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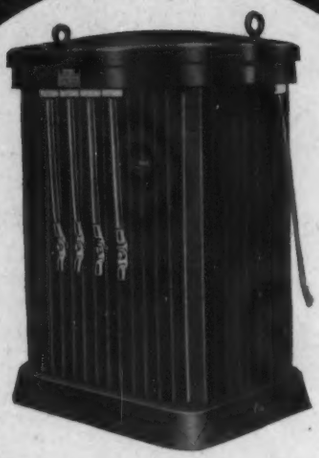

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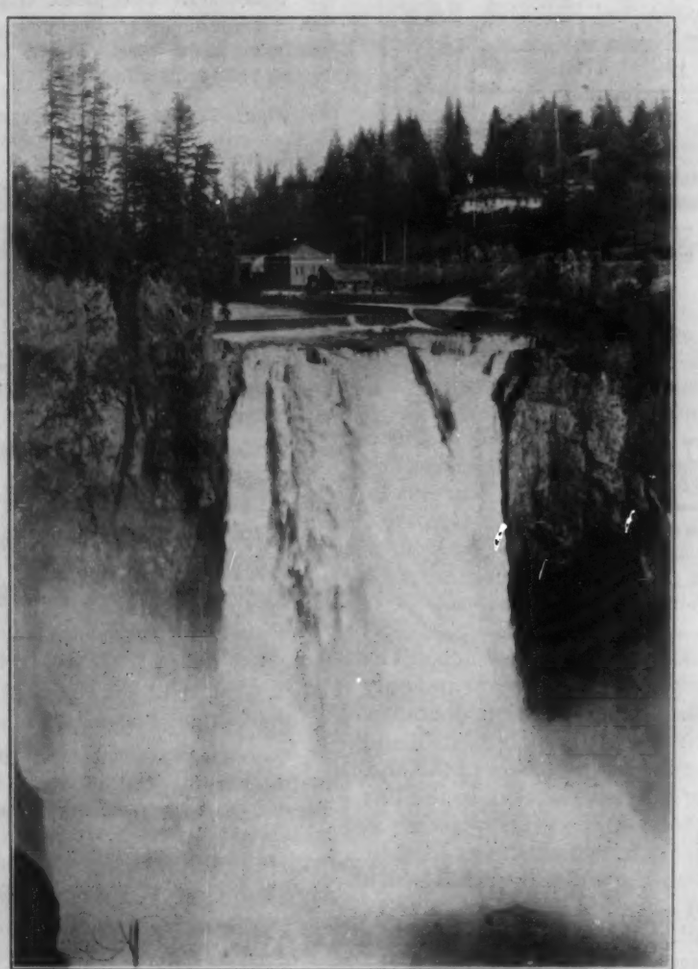
CONTINUITY OF SERVICE IN TRANSMISSION SYSTEMS[1]

BY MAGNUS T. CRAWFORD.

The object of this paper is to give the results of a number of years of operation of the Snoqualmie Falls Transmission system of the Seattle-Tacoma Power Company and to deduce therefrom practical conclusions as to the effectiveness of the method of operation used. The discussion will be confined entirely to the transmission system, and the possibilities of insuring continuous service by means of auxiliary steam plants will not be considered. Each high-tension system is a problem in itself and must be worked out with respect to its individual features and conditions, such as generating capacity in kilowatts, length of lines, size of wires, ratio of resistance and reactance, line voltage and climatic conditions. It is believed however, that a log of the operating results of a particular system is worthy of record, if the conditions of operation are correctly described.



The Snoqualmie Falls Power Plant.

The general features of the system are shown in the accompanying diagram and illustrations.

[1] A paper presented at the Pacific Coast Meeting of the American Institute of Electrical Engineers, Los Angeles, April 25-28, 1911.

A good description of the original installation as completed in 1900 may be found in Engineering News. December 13, 1900, and the evolution of the transmission line was described in a paper read before the Seattle Section of the A.I.E.E., December 19, 1908, published in the Proceedings, and in the Journal of Electricity Power and Gas Apr. 24, 1909. The present paper covers only the four years 1907, 1908, 1909 and 1910.

Outline of System of Operation.

In the operation of high-voltage lines on the Snoqualmie system the high-voltage line switches are non-automatic electrically-operated by remote control except those used in throwing the lines in multiple at substations, which are instantaneous overload release switches. The Falls operator has on his switchboard an indicating ammeter and the control handle for an electrically-operated remote-control oil switch for each outgoing high-voltage line.

The generator oil switches are kept blocked in solid on the bus bars except when synchronizing a new machine. If the Snoqualmie system is running in parallel with the Electron system or with other generating systems as is frequently the case, the

connection is made with instantaneous overload-release circuit-breakers, and a similar connection is made with the steam plant at Seattle.

When a short circuit comes on the system all automatic circuit breakers connecting other systems and all switches for multiple connections drop out at once, leaving each line separate clear to the Falls. The Falls operator first lowers the voltage and gets the speed of the machinery under control. It is then usually apparent on the line ammeters which line is short circuited, and if it does not burn clear in a few seconds

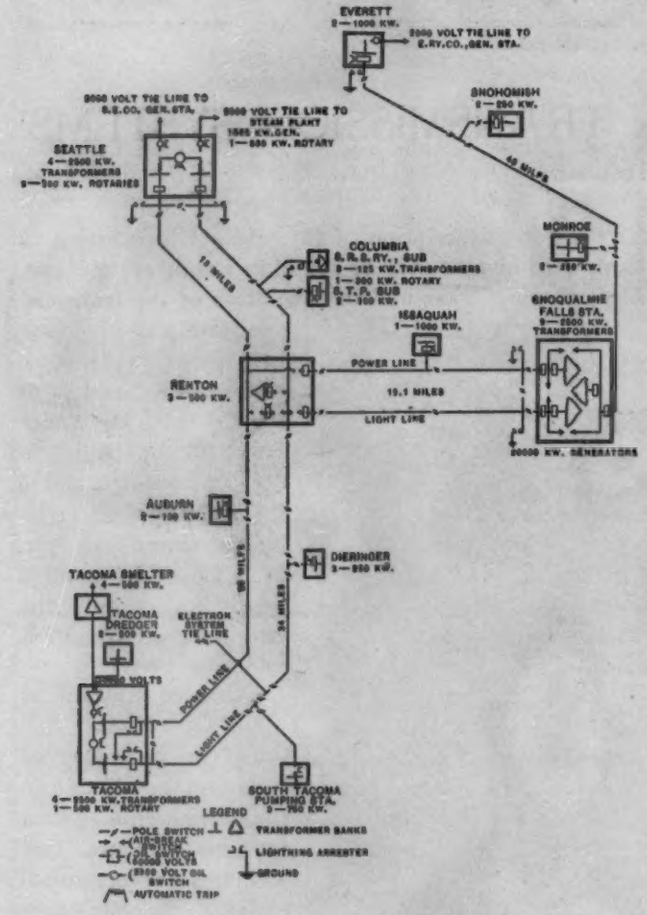


Diagram of 60,000-Volt Transmission System.

it is opened with the remote-control oil switch. The voltage is then slowly brought back to normal and only a part of the load is lost. The substation operators then open their end of their line at the pole switch, and linemen are sent out to the defective section of the line. This is located by opening all pole switches in the line and then testing out one section at a time, starting at the Falls, until a section is found which shows trouble.

If it is not apparent to the Falls operator which line is in trouble, the short circuit is fed thirty seconds, and one of the lines opened, and if it still does not clear it is fed thirty seconds longer on the other line, and the station is never shut down as long as it can be kept running. Two large water rheostats of iron wire immersed in the tailrace and provided with oil switches are thrown on the generator bus whenever a heavy load is to be dropped, as in opening a short circuited line, and serve to aid the control of speed and voltage. In extreme cases where trouble holds and all lines are

LOG OF OPERATING RESULTS.

1907.

Generator capacity 12000 kw., step-up transformers 15,000 kw. Transmission 30,000 volts three-phase, neutral ungrounded.

Poles. Cedar, average height 40 to 50 ft. (12.19 to 15.24 m.)

Spans. 135 to 160 ft. (41.14 to 48.76 m.) average length; up to 1000 ft. (304.8 m.) at river crossings.

Lines. Falls to Renton 20 miles (32.18 km.) two pole lines. Renton to Seattle 13 miles (20.92 km.), two pole lines. Renton to Tacoma 26 miles (41.84 km.) by one pole line and 34 miles (54.71 km.) by the other. Falls to Everett, 40 miles (64.37 km.) one pole line. Tacoma to Smelter at Point Defiance, 6 miles (9.65 km.) one pole line. Total 172 miles (276.8 km.)

Wires. Falls to Renton No 4/0 seven-strand aluminum. Renton to Seattle and Tacoma, No. 2/0 seven-strand aluminum. Falls to Everett, No. 4 solid copper. Tacoma to Smelter, No. 4 solid copper.

Spacing. 7 by 9 ft. (2.13 by 2.74 m.) and 7 ft. (2.13 m.) equilateral triangles.

Insulators. One piece, triple petticoat porcelain, 6 in. (15.24 cm.) diameter, Redlands pattern. White imperial porcelain on main lines. Brown porcelain on Everett line, not tested before installation.

Pins. Locust wood, impregnated with paraffine.

Cross Arms. Four by 5½ in. (10.1 by 11.13 cm.) to 5 by 6 in. (12.7 by 15.24 cm.) select Washington fir.

Switches. At Falls, non-automatic remote control, vertical break oil switches in brick compartments. At Renton, Seattle and Tacoma, non-automatic lever control, rotating horizontal break oil switches in iron tanks. At small stations and for throwing lines in multiple, fused air break "jack" switches or fused horn switches.

Protective Apparatus. Multigap lightning arresters with series resistances.

1908.

Wood pins changed to malleable iron on corners and important points.

1909.

Transmission voltage raised to 60,000 volts on December 6, 1909, using same, wires, poles and cross arms.

Insulators. Four-piece brown porcelain of standard design, each tested to 120,000 volts, and made with threaded 1½ in. (38.1 mm.) pin hole.

Pins. Malleable cast iron with threaded head.

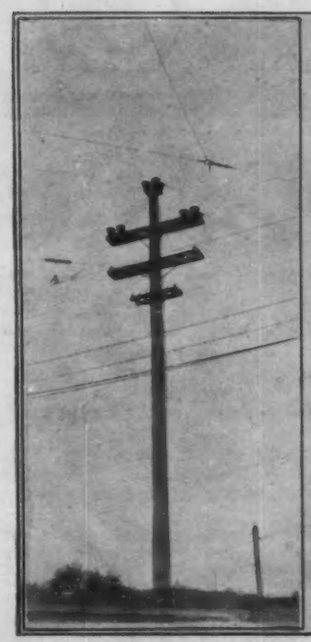
Switches. At Falls and Renton, non-automatic remote control, vertical-break oil switches in steel tanks. At Seattle, Tacoma and Everett, non-automatic lever control rotating horizontal-break oil switches in iron tanks. At small substations, series trip coil actuated automatic overload release, rotating horizontal break oil circuit-breakers in iron tanks.

Disconnecting Switches. Out-door pole top type, three-pole double break, consisting of contact jaws mounted on line insulators with connecting blades rotating in a horizontal plane.

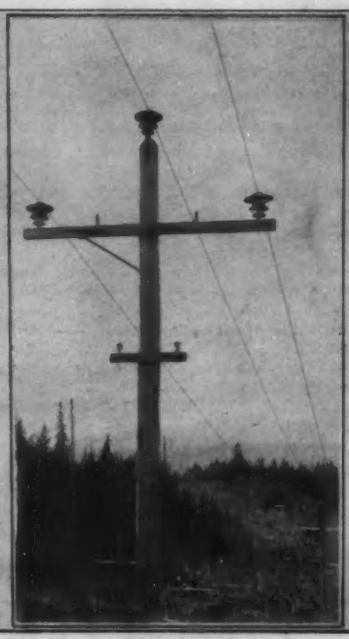
Protective Apparatus. Aluminum cell electrolytic lightning arresters installed at each end of each line.

1910.

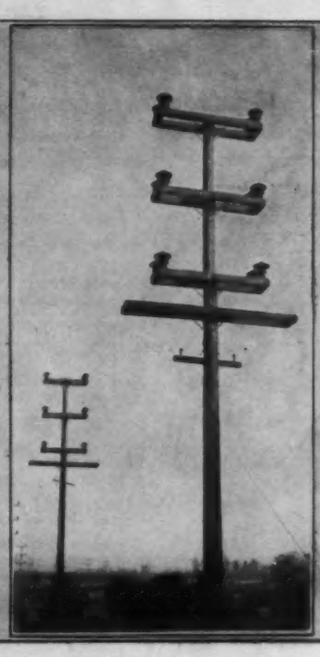
Additional 8750 kw. generator put in service in November, with 7500 kw. additional step-up transformer capacity.



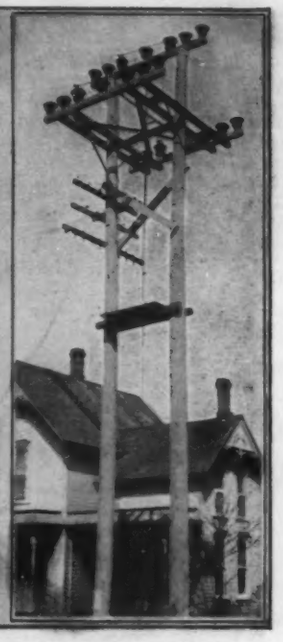
Pole-top Construction on Main Lines. (60,000 volts).



Pole-top Construction at Square Turns. (60,000 volts).



Pole-top Construction where two lines are on the same pole, showing guard wires over railroad. (60,000 volts).



Standard Pole Switch. (60,000 volts).

opened, the station is run on the water rheostats and each line thrown in again at intervals until one is found that is clear.

Substation operators open all high-tension switches when power goes off the line and immediately make connections with another generating system or steam plant, and pick up the local load until power comes on the lines again.

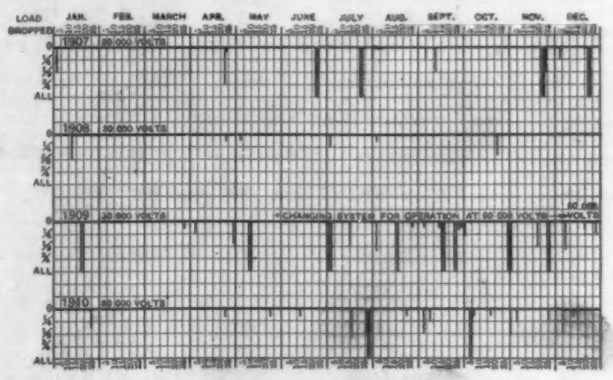
The details of the system of upkeep employed in connection with the transmission system have been carefully worked out, as a great many of the interruptions in service may be avoided by proper maintenance of the lines. Eight patrolmen are employed and each held responsible for the condition of a part of the line. They are stationed at a transforming station as near as possible to the middle of their patrol, and furnished with a residence and a telephone from the private line. Patrolmen are furnished with a saddle horse and saddle bag containing telephone test set, sundry tools and material, and once each week they carefully inspect their section of the line. All badly broken insulators are replaced and any other necessary repairs made. Every two miles along the line a small booth is fastened to a pole, and a stock of insulators, pins, cross arms, line wire, etc., are kept locked up therein, so that in case of trouble, material for repairs will always be within one mile.

Each patrolman also has charge of the pole switches in his territory and once a month he makes a complete and thorough examination of each switch, keeping the parts well oiled and in perfect alignment. Each week he makes a written report on a printed form of the results of his line patrol and switch examination.

When any repair work is to be done on a high-tension line, it is killed and opened by an air-break switch at each end, and the lineman working on the line makes a solid short circuit and ground at the point where he is working, with a flexible cable provided for the purpose. All lines are in charge of the station operator, and linemen notify the operator by telephone when a line is desired, waiting until he is told the line is dead before doing any work thereon. All communications between employees in connection with high voltage are repeated back to the speaker, and are written down in the station log book. These precautions are necessary to reduce mistakes to a minimum.

Explanation of Tables.

The following tables and curves show a log of the operation of the transmission system for the last four years. All cases of trouble on the high-tension lines or in transformers that caused an appreciable disturbance of the line voltage are recorded, but short circuits on low-tension distribution systems and other troubles not chargeable to the transmission system are excluded. The times given as "shut down" are cases where power



Service Interruptions on the Snoqualmie Transmission System.

was off the high tension lines of the Snoqualmie system long enough to switch out the defective line. The actual service interruptions were of very short duration, as power was usually obtained immediately from

TABLE I.

SERVICE INTERRUPTIONS.

Date	Extent	Load dropped	Remarks.
1907 Jan. 2 9:55 p. m.	Short voltage dip	About half	Snow on outlets at transformer house at Falls makes short circuit on power line by starting an arc. Falls operator opened power line and cleared trouble, throwing on water rheostats until load returned.
Jan. 3 1:10 a. m.	Short voltage dip	None	Short circuit on light line, burned clear. Cause unknown.
April 23 4:15 p. m.	Prolonged voltage dip	Nearly all	Telephone wires blown into high-tension wires near Seattle by high wind. Burned clear.
April 24 6:04 p. m.	Four seconds voltage dip	Small	Short circuit on system, cause unknown. Burned clear.
June 24 2:15 p. m.	Shut down	All	Solid short circuit on both lines holds until lines are opened. Cause unknown. No trouble found when lines are put in again.
July 23 8:30 p. m.	Shut down	All	Piece of iron wire thrown over both lines near Tacoma. Falls operator pulled the short circuit 30 seconds on each line before shutting down, but unable to burn clear.
August 1 7:50 p. m.	Eight seconds voltage dip	One-fourth	Arc started by lightning between wires at outlets in Seattle substation. Burned clear by lowering voltage.
Sept. 5. 1:15 p. m.	Dip in voltage	One-fourth	Severe short circuit comes on light line but is burned clear. Cause unknown.
Sept. 11 12:45 p. m.	Dip in voltage	Nearly half	Lightning storm between Renton and Tacoma. Short circuit appears on both lines but burns itself clear.
Oct. 16 10:00 a. m.	Small voltage dip	Small	Light short circuit on power line is burned clear. Caused by limb from burning tree between Auburn and Tacoma.
Nov. 22 2:45 p. m.	Shut down	All	Wooden insulator pins burned off on corner pole between Renton and Kent causing short circuit and ground on light line. Arcing ground burns up nearly two spans of wire at point of break. Surges burn up multigap lightning arresters in stations and cause pins to burn off at other points on lines where insulators were defective.
Nov. 23 5-6 p. m.	Frequent successive voltage dips	About half	Trouble develops from burned insulator pins at different points probably at places where insulators were cracked by surging ground of Nov. 22. Pole near Everett was set on fire and Everett line was out until repaired. One wire of light line in Seattle burned off cross arm and came across 13,000-volt lead of S. E. Co. As Seattle power line was cut out for repairs at other points, Seattle was out eight minutes. One transformer punctured at Seattle. Falls line also down from burned off pins near Renton but cut out before causing damage, and repairs made.
Dec. 4 3:30 p. m.	Six second dip	One-fourth	Short circuit appeared on light line and is burned clear. Low tension wires got tangled up on pole in Auburn and one of them swings up over high-tension line and is burned off. Caused by high winds.
Dec. 23 4:00 p. m.	Shut down	All	Heavy wind storm blows limb of tree into light line near Issaquah, blows down power line near Kent and light line near Auburn, all at same time. Last two places were where pins were nearly burned off. Falls operator lowered voltage and stayed in on each line separately for 60 seconds, but was unable to clear trouble. Station ran on water rheostats until troubles were located and one line repaired through.
1908 Jan. 12 5:00 p. m.	Voltage dip	About half	Short circuit on branch line to smelter in Tacoma. High-tension fuses in Tacoma substation did not open and short circuit was pulled 30 seconds by Falls operator and burned clear. Cause unknown.
April 24 3:50 a. m.	Ten seconds voltage dip	Small	Tree blown into Falls light line one-half mile (0.8 km.) from Renton. Light line opened and trouble cleared.
April 24 4:20 a. m.	Short voltage dip	Small	Everett line down near Snohomish due to defective insulators. Everett line opened and trouble cleared.
May 2 1:50 p. m.	Short voltage dip	Small	Defective insulators on line to Tacoma lets wires down on cross arm. Cross arm burned off, clearing trouble.
July 2 3:15 p. m.	Ten seconds voltage dip	One-fourth	Short circuit and ground on power line due to defective pole switch at Seattle. Seattle operator knew location of trouble and cleared it by opening high-tension line oil switch.
August 3 9:45 p. m.	Short voltage dip	Small	500-kw. transformer burned out at Lewis & Wiley's pumping station. Cleared by high-tension fuse in substation.
Oct. 22 4.32 a. m.	Voltage dip	Nearly half	Short circuit on line to dredger in Tacoma harbor cleared by high-tension fuse. Caused by salt water fog where line runs about 30 ft. (9.14 m.) from surface of water, and spacing between wires only 3½ ft. (8.9 cm.)
1909 Jan. 3 8:10 p. m.	Short voltage dip	Small	Short circuit on Tacoma dredger line. Cleared by high-tension fuses. Caused by salt fog.
Jan. 19 2:30 p. m.	Shut down	All	Line to Tacoma smelter was connected to both light and power lines at Tacoma substation when a land slide carried away several spans. Falls operator lowered voltage and kept each line in 30 seconds before opening.
March 26 5:00 a. m.	Short voltage dip	Small	500-kw. transformer burned out at Lewis & Wiley's pumping plant. Cleared by high-tension fuse in substation.
April 4 8:45 p. m.	Long voltage dip	One-fourth	Severe short circuit on Tacoma dredger line holds until voltage is lowered. Probably from salt fog.
April 29 8:20 a. m.	Voltage dip	Nearly half	Transformer burned out and grounded on Tacoma smelter line. Discharges lightning arresters in Seattle and Tacoma substations.
May 10 11:25 a. m	Shut down	All	Burning tree falls into Tacoma power line near Auburn, breaking down four spans of line, causing arcing ground that results in puncture of No. 1 generator armature. Lines opened until defective generator could be cut out and load picked up on rest of station.
July 2 5:15 p. m.	Shut down	All	While Tacoma power line was cut out for work thereon, light line was connected to both Falls lines and a tree was blown into the light line near Auburn, making a short circuit and ground which would not burn clear. Both lines had to be opened until defective line could be switched out at Renton.
July 3 12:35 a. m.	Heavy voltage dip	Small	Short circuit on power line burned clear. Linemen repairing break of July 2d on a dark night left telephone wire across line, and when line is switched in at Renton telephone wire is fused.
July 15 10:30 a. m.	Voltage dip	Half	Short circuit on light line near Seattle, cause unknown. Light line opened, clearing trouble.
August 2 12:15 p. m.	Sixty seconds voltage dip	Over half	Falls line cut out for linemen to work on about 3 miles (4.8 km.) from Renton. A solid short circuit and ground put on wires where they were working with a piece of ¼-in. (6.35 mm.) steel mast arm rope, as a safety precaution. By mistake line was reported clear and switched in at Renton end with short circuit still on and Renton multiple switch closed solid. Falls operator lowered voltage and pulled the short circuit by way of light line and Renton multiple switch. In about 60 seconds the ¼-in. (6.35 mm.) steel rope was fused clear of the line, and water rheostats were thrown on generator bus.
August 16 5:20 p. m.	Shut down	All	Steam shovel gets into line at Seattle, letting down two spans and causing arcing ground and short circuit that punctures two transformers and No. 5 generator at Falls. Station shut down until defective apparatus could be cut out.

Date	Extent	Load dropped	Remarks.
August 26 2:50 p. m.	Short voltage dip	Small	Short circuit in 500-kw. transformer at Lewis & Wiley's pumping plant. Cleared by high-tension fuse in substation.
Sept. 4 2:35 p. m.	Voltage dip	Everett only	Short circuit on Everett line, cause unknown. Cleared by high-tension fuse on Everett line.
Sept. 13 12:15 p. m.	Voltage dip	Everett only	Short circuit on Everett line caused by blasting stump into line. Cleared by fuses on Everett line.
Sept. 16 3:20 p. m.	Shut down	All	Seattle light line short circuit and grounded by blasting stumps near Seattle. Arcing ground punctures No. 3 generator armature and station is shut down.
Sept. 24 7:00 p. m.	Shut down	All	Pile driver knocks down long span in Everett line across Snohomish River. Fuses blow on Everett line and start arc across wires, short circuiting high tension bus in transformer house at Falls; station shut down until bus could be cleared.
Sept. 26 7:12 p. m.	Voltage dip	Everett only	Short circuit on Everett line cleared by fuses. Pile driver strikes line at Snohomish.
Sept. 27 2:40 p. m.	Voltage dip	Small	Pole switch at Puyallup does not close properly and starts arc across wires when opened. Burned clear by lowering voltage.
Sept. 30 8:05 p. m.	Heavy voltage dip	One-fourth	800-kw. transformer burned out at South Tacoma pumping station. Cleared by fuses in substation.
Oct. 31 10:35 a. m.	Shut down	All	Light line cut out for work thereon when power line was torn down by blasting stumps near Kent. Falls operator was unable to burn the trouble off and cut both lines out until Renton switched clear of the trouble.
Nov. 18 1:30 p. m.	No shut down of system	Half	Floods and high winds washed out 12 poles carrying both light and power lines near Tacoma, and they were blown over. Trouble reported and lines opened before they went down. Wires not broken and poles were pulled up clear of the ground and lines cut in.
Nov. 25 9:00 a.m.	Shut down	All	Flood washes out Everett line near Snohomish. Wires and switching in temporary condition at Falls during change to 60,000 volts, and unable to clear without shut down.
Dec. 5.			SYSTEM CHANGED FROM 30,000 TO 60,000 VOLTS WITHOUT INTERRUPTION IN SERVICE.
Dec. 6 10:28 p. m.	Heavy voltage dip	Over half	Limb of tree blown into light line 2½ miles (4 km.) from Falls breaking wires and causing short circuit and arcing ground. Electrolytic lighting arresters discharged taking heavy surges off of line. Light line opened by operator clearing trouble; water rheostats thrown on until load returned.
Dec. 20 10:15 a. m.	Voltage dip	Small	Pole switch arced across at Renton when opening Tacoma light line. Switch closed again and dip of voltage breaks arc.
Dec. 27 3:10 p. m.	Heavy voltage dip	One-fourth	Short circuit on Everett line cleared by opening line switch at Falls. Caused by blasting stump into line a few miles from the Falls, breaking wires.
Jan. 25 8:07 p. m.	Voltage dip	Nearly half	Severe short circuit cleared by opening light line. Multiple switches at Seattle and Tacoma drop out. Trouble caused by high wind blowing over a corner pole near Kent, the line falling into a lead of telephone wires. Telephone system damaged but slightly.
April 16 12:25 p. m.	Slight voltage dip and swinging of ground detector	None	Ground appears on system but burns clear in a few seconds. Caused by blasting stumps 300 ft. (91.44 m.) from line near Milton. Large rock breaks one wire of line and it falls to ground burning off clear at Falls end. Trouble located and line cut out and repaired.
April 24 9:05 a. m.	Voltage dip	Small	Pole switch on Tacoma light line arced across at Renton when opening charging current of line with blades set too close. Cleared by opening light line at Falls.
May 23 8:15 p. m.	Voltage dip	Small	Light short circuit burns clear at once. Tree fell across light line near Renton but did not break wires. Renton operator notified of trouble and opens line at Renton.
June 12 11:35 p. m.	Slight voltage dip	Small	Surge appears on light line and ground detector, clearing immediately. Transformers at South Tacoma pumping station burned out. Trouble cleared by high-tension fuse in substation. This substation owned and operated by consumer.
July 16 9:15 a. m.	Prolonged voltage dip	Over half	Pole switch at Renton arced across when opening charging current of line, with blades set too close. Short circuit appears on both lines and Falls operator opened light line. As this did not clear trouble light line was closed again and power line opened clearing trouble.
July 26 8:10 a. m.	Heavy voltage dip	Half	Short circuit appears on Everett line and is burned clear. Cause unknown.
July 26 9:45 a. m.	Shut down	All	Tree blew across Everett line breaking wires down. Remote control handles for line switches were in a temporary location at one side of switchboard while some new panels were being put into position. Operator made mistake in switchiing and had to open all lines and throw on rheostats until generators could be controlled.
August 22 1:35 p. m.	Slight voltage dip	Small	Ground appears on light line, discharging electrolytic lightning arresters. Burns itself clear. Cause unknown.
August 26 6:35 p. m.	Slight voltage dip	None	Ground develops and clears itself. Cause unknown.
Sept. 3 11:15	Voltage dip	Half	Telephone wires pulled across power line in Seattle by careless lineman. Power line opened by operator and trouble cleared. Half of load dropped as Tacoma was running on power line with light line cut out temporarily.
Sept. 7 11:05 a. m.	Voltage dip	One fourth	Short circuit on Everett line from unknown cause. Trouble clears when Everett line is cleared.
Oct. 4 11:25 p. m.	Shut down	All	Corner pole cut down with an axe near Tacoma, both light and power lines falling across county road and telephone lead. Falls operator unable to burn clear and both lines left out until defective section could be opened. Telephone Company's system not damaged severely.
Oct. 5 11:15 a. m.	Voltage dip	Small	Short circuit on light line burns itself clear. Cause unknown.
Oct. 17 3:15 a. m.	Voltage dip	Small	Short circuit cleared by opening Everett line. Stump blasted into line by contractor building new railroad near line.
Oct. 30 11:03 a. m.	Heavy voltage dip	Over half	Short circuit appears on both lines but burns itself clear. Cause unknown.
Nov. 4 5:40 p. m.	Two successive voltage dips	One-fourth	Stump blasted into Everett line. Trouble burned clear.
Nov. 25 8:05 p. m.	Voltage dip	One-fourth	Short circuit appears and is burned clear in a few seconds. Caused by blasting piece of stump into Everett line.
Dec. 5 7:00 p. m.	Three severe voltage dips	Half	Malicious persons throw piece of half-inch (14.7 mm.) steel cable over both light and power lines about three miles (4.82 km.) from Renton on Seattle lines. Steel cable was burned in two and trouble cleared on power line although line wires were badly scarred. On light line one line wire was burned in two, fell to ground and burned off clear of ground on Falls side. Falls operator did not open any lines, as short circuit appeared the same on each and was burned clear.
Dec. 11 12:15 a. m.	Voltage dip	Small	Defective insulator on pole switch at Seattle punctures and starts arc to ground. Electrolytic lightning arresters flash over, taking surge to ground and trouble burns itself clear.

another system or steam plant at Seattle, Tacoma and Everett.

The conditions of transmission are somewhat severe, as the lines pass through rough country and along country roads. The land is being cleared for agricultural purposes and for new railroads, so that a great deal of blasting and grading is being carried on, causing much trouble. The pole line has been built ten years, and has not the mechanical factor of safety of a new line. The tables show how the troubles resulting from these adverse conditions were handled with a minimum disturbance to service, as out of the total of 66 cases of trouble given in the table, 52, or about 80 per cent, were handled without an interruption of service.

During the latter part of 1907 considerable trouble was caused by burned wooden pins. These pins had been in service nearly seven years, and the threaded tops were softened to pulp, apparently by the action of nitric acid formed from the air, and moisture by the leakage currents.

TABLE II.

SUMMARY OF SERVICE INTERRUPTIONS 1907-8-9-10.

		Voltage dips.		
	Shut downs	Dropping Half load	Dropping Quarter load	Total cases
1. Defective line construction, failure of switches, insulators, etc.	1	2	7	10
2. Failure in transformers	0	1	5	6
3. Malicious interference, blasting stumps, etc.	6	1	7	14
4. Winds, fires, floods, fogs, etc.	6	6	6	18
5. Lightning	0	1	1	2
6. Mistakes by employees	0	2	1	3
7. Unknown	1	4	8	13
Totals	14	17	35	66

Note.—Of the fourteen cases of shut down, seven occurred during the half of 1909 when the system was running on one line during working hours to permit reconstruction for 60,000 volts. During the other 3½ years the average was two cases of shut down per year.

The line was gone over by patrolmen and on all turns and important places the wood pins were replaced by malleable iron pins, and no more trouble resulted from this cause. With the weak points thus fixed the system gave practically continuous service during the year 1908. During 1909 the work of re-construction for 60,000 volts was in progress and nearly half of the system was cut out during working hours for work thereon, and the switching was in a temporary condition at many places. These circumstances made it difficult to handle trouble without interruption of service. During the year since the change to 60,000 volts there have been only two shut-downs out of 23 cases of trouble, showing the method of operation is equally successful at the increased voltage.

The duplicate high voltage lines are known by the names light and power lines respectively, and are divided into sections known by the names of the principal stations toward which they lead from the junction point at Renton.

Discussion of Results.

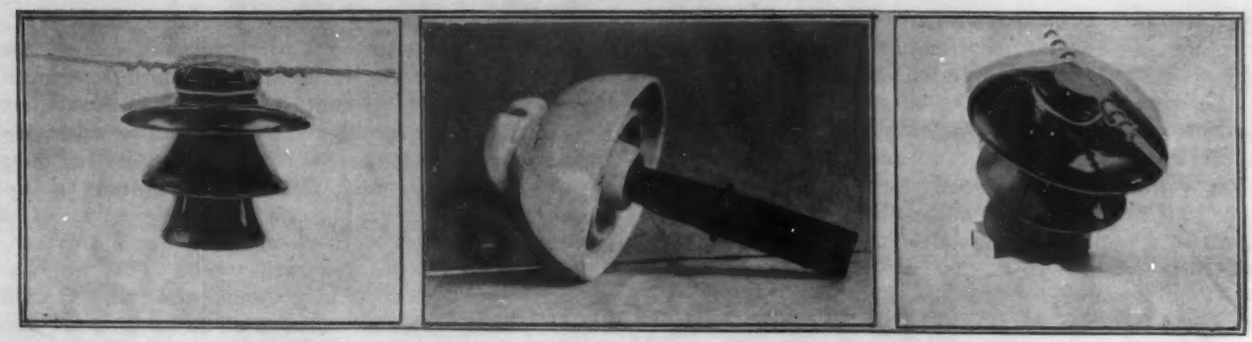
Before discussing the above results, a definition of continuous service is necessary. In cases where only a voltage dip is shown, the bus voltage of 115 volts dipped down to some value between 40 and 90 volts for a few seconds and then returned to normal. To the lighting consumer this is not objectionable if it does not occur too frequently. To the small power consumer, such as shops and industries using motors in small units, generally speaking it is not a serious inconvenience, as the motors will often come back up to speed and will at most only require restarting. In the case of very large power units, they will usually stay in on the line unless they are heavily loaded or the dip is too prolonged.

The 500-kw. synchronous converters on the system almost always stay in and are not cut off until the current goes cleear off the line. On the other hand if the voltage dip is very sudden in its return to normal, as where a short circuit is opened at its maximum and a Tirrill regulator has held up the generator voltage, large synchronous machines are much more apt to be thrown out. In the above table there are 52 cases where the voltage dipped but the system was not shut down, and in only 17 of these cases was the dip sufficiently prolonged to lose any considerable amount of load. In the other cases practically all the large motors stayed on the line. It seems reasonable then to conclude that moderate voltage dips of short duration do not constitute an interruption worth considering.

In cases where the voltage gets to a very low value and does not return to normal for ten seconds or more, the most of the power load will be dropped, but the lighting load will be retained. The power consumer is then put to the inconvenience of stopping work long enough to start up his motors again. The railway station operator must synchronize his converting units again, but if the drop is not over thirty seconds they should still have considerable speed and this should only be a few minutes work, which is not a hardship to railway service. Some power installations will suffer great inconvenience, such as for instance an ammonia compressing outfit, and also some electrolytic processes, where even a momentary shut down will cause heavy loss. However, such consumers will only form a small percentage of the average power company's business, and any expensive equipment to insure them absolutely continuous service should be a part of their own installation.

In cases where power goes completely off, all load is dropped and all consumers suffer maximum of inconvenience until service is resumed. The gross income of the power company practically ceases and the operating expenses continue, besides the loss in good will which can not be measured. If service is resumed within five minutes, the average consumer will not suffer serious loss, but where the shut down extends over thirty minutes or an hour the financial loss and inconvenience is very considerable to all parties concerned. We may then conclude that prolonged voltage dips are an inconvenience but if of infrequent occurrence are not serious menaces to satisfactory service, whereas complete shut-downs cause heavy loss. Speaking from the average consumers viewpoint, commercially continuous service may include infrequent voltage dips and very rare shut-downs of periods never exceeding five minutes.

Causes of Troubles. The first two causes in Table II are defective construction and apparatus, and burnouts of machinery. By testing all line insulators for a voltage a little over twice normal and carefully testing all machinery winding before installation the entire system may be made to withstand double normal volt-



Center View Shows Porcelain Insulator and Iron Pin for 30,000 Volt Line. Pictures on either side show type of tie and 60,000 Volt Insulator, 4/0 Seven-Strand Aluminum Cable With No. 2 Tie Wire.

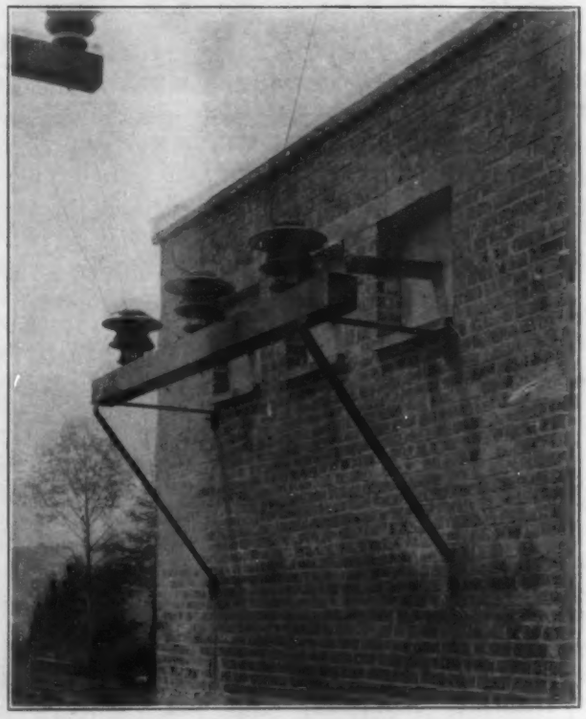
age for several minutes without failure of insulation. This means that transient voltages considerably in excess of double normal voltage can be withstood, as brought out by Steinmetz and Hayden in a paper before the A.I.E.E. in June, 1910. By installing protective apparatus such as air relief gaps which are set to break down at double voltage and which have a time lag much lower than that of the insulation of the system, practically all destructive surges can be taken off the system. This may be done by installing electrolytic lightning arresters at the entrance to all important stations. If lightning becomes so troublesome as to shatter insulators on the line where it strikes at some distance from an arrester, relief gaps may be installed at each insulator if necessary, by means of arcing rings as described by Nicholson in a paper before the A.I.E.E., March 30, 1910. In this plant, however, lightning strokes on the line are very rare, and by using wood poles and cross arms, an entire pole may be burned down without interrupting service if the wires are not broken. The first two causes of trouble and also the sixth can thus be reduced to a minimum by properly testing the insulation of apparatus and the installation of protective apparatus.

Blasting stumps is a source of much annoyance in this section of the country, and can best be handled by a campaign of publicity. The patrolman on each section of the line should make it his business to become personally acquainted with all the ranchers enroute and keep his eye open for all evidences of preparation for clearing land, and when he sees blasting is to be done call attention to the notices of warning kept on each pole, and show every desire to cooperate with the parties concerned and have the line killed before blasting is done. Deliberate interference should be prosecuted vigorously by arrest and fine where possible.

Troubles from winds, fires, floods, etc., can be mitigated by using a very large factor of safety in the mechanical construction of the line, and by putting the high tension wires at a good height above all telephone and other wires easily broken. Structures in soft soil should be set solidly in rock boxes and well braced, lines taken via separate routes whenever possible, and always on separate pole lines. All large trees that can blow into the line should be bought and cut down, and the brush kept closely cut on the right of way.

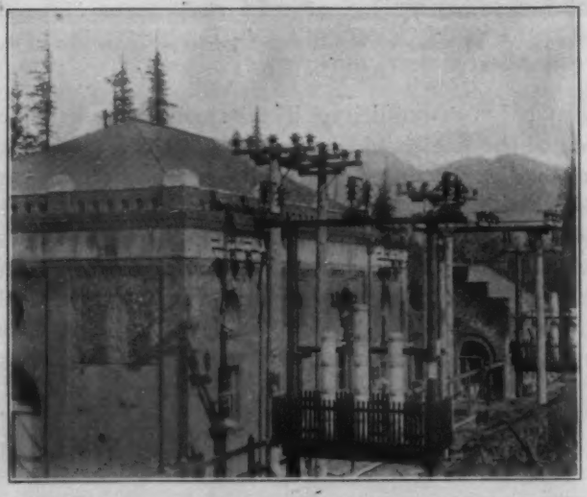
30,000-Volt Entrance Construction.

Malleable cast iron pins. Cross-arm pin fits 1½-in. hole in old cross-arms. T-headed bolt slips into a seat on a shoulder cast on inside of shank at bottom, and is tightened up under cross-arm. Weights 3¾ and 7 lb. Ultimate strength 1800 lb. at line wire. (60,000 volts).



Entrance Tubes at Substations (60,000 volts).

Mistakes of employees can be reduced by providing them with definite written instructions on their duties and course of action under various conditions and by providing them with the best working equipment. Station operators in a plant employing non-automatic operation are very important units in the system; a little welfare work and good pay to good men, and in fact anything that will make them take interest in their work and pride in good results will prove an excellent investment.



Switching and Lightning Arresters at Snoqualmie Falls.

Results of Method of Operation. The standard practice in the operation of duplicate transmission lines is to install automatic overload relays and circuit breakers on each line at the generating station, and reverse current relays with automatic circuit breakers at the substation. Even with complicated systems this idea may be carried out so that theoretically a short circuit anywhere on the system will automatically be cleared and the defective line cut out. The experience of this company has been that practically better results can be obtained by placing the control of the high-tension lines in the hands of a carefully trained operator. From the operation of this system it is believed that the non-automatic method of operation is less apt to produce destructive oscillations when a short circuit is being cleared from the system. Taking for instance a case where a piece of iron wire is thrown across the line. There being no automatic regulation except slowly acting water wheel governors, the speed and voltage of the generating units dip severely. The operator encourages this and blocks the action of the governors, feeding the short circuit at the reduced voltage. The low-frequency high-power surge first set up by the short circuit may thus be reduced in intensity, being also dissipated by the resistance and cushioned by the reactance of the line, and the station is then simply running on a severe overload for a few seconds. If it is apparent which line is short circuited, it may then be opened with safety. If on the other hand the voltage and speed are automatically held up as far as possible by Tirrill regulators and governors, and the surge is ruptured at a point other than zero in the wave, a destructive potential will result which may cause damage.

In the case of an arcing ground a more severe condition exists than in a short circuit, as in cases where one line wire is whipping around on the ground, making and breaking contact. In this system where the neutral is ungrounded severely unbalanced strains may be produced in this way, as is shown by the puncturing of generator and transformer windings in such cases. An arcing ground was not always visible on the line ammeter, and an electrostatic ground detector was installed on the generating bus. This indicates promptly all high-tension grounds, and the telephone circuit along the same poles is an instantaneous indicator showing which line is grounded. Grounded lines are cut out without attempting to burn clear, and the installation of electrolytic arresters on the lines, transformers with reinforced insulation on the end coils and static relief gaps on the generating bus bars has given entire freedom from trouble from arcing grounds, as shown by the absence of failures of insulation since the installation of the new equipment in 1909.

Since the change to 60,000 volts it has been the practice to open the defective line if it does not burn clear in about five to eight seconds instead of holding for thirty seconds. By the installation of a Tirrill regulator with a special relay for lowering the voltage during a short circuit the operator does not have to look after the voltage, and with accurately reading deadbeat line ammeters he is able to see the situation inside of five seconds. This equipment has been recently installed. The switches for multiple connections now installed on the low-tension side at substations work instantly instead of in the slow uncertain manner of the old 30,000-volt fuses used for this purpose, so that much better performance can be expected in handling short circuits in the future.

This method of operation is applicable to a system of several generating stations, by giving each generating station a certain amount of transmission system, and then using instantaneous automatic circuit breakers at the point of connection. These circuit breakers can be set to carry the full value of interchange current so that the plants can be operated in parallel and with any desired sharing of load; but when a short circuit comes on the line, that line and its generating station will immediately be separated from the rest of the system and can clear its own trouble. Mr. Downing's paper before the San Francisco meeting in May, 1910, on the "High Tension Network of a General Power System" describes a system operated in this way.

It is apparent from this paper that there are a number of features which an engineer could employ in building a new line that would prevent many interruptions, such as stringing the lines at a greater height and supporting them on strong structures along private right-of-way, to avoid interference. The desirability of continuous service depends on the character of the power business served, and a balance may be struck at a point where further investment to secure greater reliability may not be warranted.

Eectrolytic iron of great purity can be obtained from mild steel anodes. It requires 1 kw.-hour to refine 2 lb. of iron and the cost of labor, maintenance and fixed charges has been estimated at $10 per ton of iron produced.

WASHINGTON PUBLIC SERVICE COMMISSION.

The newly created Public Service Commission in the State of Washington consists of three members appointed by the Governor with the consent of the Senate, for six-year terms. Each commissioner is to receive a salary of $5000 a year. A secretary to receive $2000 a year salary is to be appointed by the commission. Other officers of the commission are to be a rate clerk and statistician at not more than $3000 a year, an engineer at not more than $3000 a year, an inspector of safety appliances at not more than $3000 a year, an expert accountant at not more than $1800 a year, a stenographer at not more than $1800 a year, and such engineers, inspectors, accountants and other assistants as the commission may deem necessary. The commission is to have jurisdiction over all public service companies in the State.

The commission is authorized to fix rates, fares or charges, and where rates, fares or charges are insufficient to yield reasonable compensation the commission is empowered to determine the charges and to fix the same by order. It is also given power to fix joint rates and through routes on railroads. Every public service company is to notify the commission of every accident which results in death or injury to any person. The commission is authorized to investigate all accidents and to order repairs or changes in railroad property wherever it deems changes or repairs necessary. It may even compel the suspension of traffic until repairs are made.

Copies of all complaints are to be served upon the companies affected and not less than ten days are to intervene between the date of service of the complaint and the hearing. All orders and findings rendered by the commission are to become operative twenty days after service, unless the commission deems that additional time is reasonably necessary to comply with the order. Every company that violates an order of the commission is liable to a fine of $1000 a day for each offense and every officer or employe of a company who violates an order of the commission is to be deemed guilty of a gross misdemeanor.

Appeal for a writ to review the finding of the commission may be made to the Superior Court of the county in which the proceeding was instituted within thirty days of the date of the order of the commission, and the court is empowered to restrain the commission from enforcing its order pending the determination of the suit. Appeal from the finding of the Superior Court may be made to the Supreme Court of the State. The transcript of the proceedings before the Superior Court is to constitute the record on appeal to the Supreme Court.

When complaint has been made to the commission concerning the reasonableness of any rate or charge and the commission has determined that the charge is excessive, the commission may order the company to pay to the complainant the amount of the overcharge with interest from the date of collection. If the overcharge is not paid within the time fixed in the order, suit may be instituted to recover same, and the findings and order of the commission are to be prima facie evidence of the facts therein stated. "All complaints concerning over-charges shall be filed with the commission within two years from the time the cause of action accrues, and the petition for the enforcement of the order shall be filed in the court within one year from the date of the order of the commission."

The commission is authorized to inspect the books and other documents of any public service company and to examine under oath any employe. Every company is to report annually to the commission and answer specifically all questions propounded by the commission. The annual reports are to include the amount of capital stock issued, the dividends paid, the surplus fund, if any, the number of stockholders, the funded and floating debts and the interest paid thereon, the cost and value of the company's property, details of franchises and equipment, the number of employes and the salaries paid each class, the accidents to passengers, employes and other persons, the cost of the accidents, the amounts expended for improvements and such information in relation to rates, charges and contracts as the commission may require. The commission is also empowered to require any public service company to file a monthly report of receipts and expenses.

In regard to the valuation of the property of the public service corporations the measure says in part:

"The commission shall ascertain the cost of construction and equipment and the cost of reproducing in its present condition the property of every public service company; the amount and present market value of the capital stock and funded indebtedness of every company; in the case of companies engaged in interstate business, the relative value of the use to which such property in this State is actually put in the conduct of interstate business and State business respectively; the total market value of the property of each company; the time intervening between the expenditure of money in the cost of construction and the time when returns in the shape of dividends were first received; the probable earning capacity of each company under the rates now charged and the sum required to meet fixed charges and operating expenses, and in case of a company doing interstate business the probable earning capacity of intrastate business and the sum required to meet fixed charges and operating expenses on intrastate business, and the relative proportion of intrastate and interstate business, the relative proportion of the operating expenses connected therewith, the relative proportion of the revenue which should be derived therefrom; the density of traffic and of population tributary to every company; the existence of grades, curvatures and other physical conditions affecting the movement of traffic and business of common carriers, and whether the expenditures made in procuring property were justified by the existing conditions, and whether the money expended has been reasonable for the present needs of the company, and for such needs as may reasonably be expected in the immediate future."

The sum of $118,146.68, or such sum as may be necessary, is appropriated to carry out the provisions of the act.

AN ELECTRIC FURNACE FOR ZINC SMELTING.[1]

BY FRANCIS A. J. FITZ GERALD.

There is no branch of metallurgy which is apparently more suited to electric furnace treatment than that of zinc smelting. The regular method of zinc smelting is extraordinary in its crudity, inefficiency and expense, hence the relatively high cost of heat generated electrically is not by any means so serious a consideration as in certain other metallurgical processes. Moreover the electric furnace possesses certain characteristics which make it specially applicable to the conditions of zinc smelting. In the following paper it is proposed to describe briefly a new form of electric furnace originally designed for zinc smelting, although it has useful applications in other kinds of work.

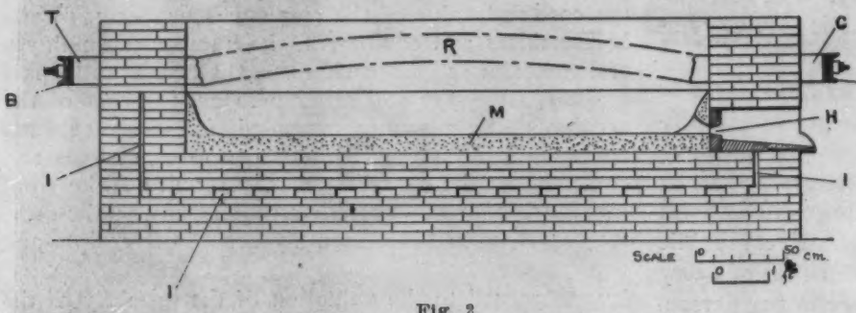


Fig. 2.

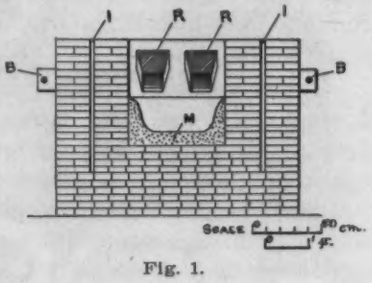


Fig. 1.

It is not intended to discuss here the metallurgy of zinc smelting, but to appreciate properly the electric furnace which will be described it will be necessary first briefly to consider the particular method of zinc production for which the furnace was designed. It has long been known that when zinc sulphide and metallic iron are strongly heated the following reaction takes place:

$$ZnS + Fe = Zn + FeS$$

but the reaction does not seem to be complete unless there is a relatively large excess of iron, or unless the temperature of the reaction is very high, Imbert, however, discovered that by using suitable "dissolvents" this objection to the process is overcome. Imbert, for example, found that ferric oxide and iron sulphide mixed together in the proportion of one part and three parts respectively formed a fluid bath at a temperature between 1000 degrees and 1100 degrees Centigrade, and that this bath would "dissolve" six parts of blende. Now when the blende is "dissolved" in a bath in this way the reaction with iron mentioned above takes place with the greatest ease, is complete, works at a comparatively low temperature and as a residue produces two distinct substances — A slag consisting of the gangue from the ore and a ferrous matte which may be used for the regeneration of iron, etc.

A great many experiments were made with this process and the results were highly satisfactory, except that it was difficult to construct a suitable furnace for the purpose. Obviously working the process in the ordinary zinc retort furnace would not be satisfactory, for the process should be carried out with a much larger unit than a zinc retort. When it comes to applying fuel heat to such a process numerous difficulties arise which are sufficiently plain without mentioning them in detail. This naturally led to the idea of using an electric furnace and many experiments with various kinds were made. Finally Mr. John Thomson and the author designed a furnace which was used on a large scale in the working of the Imbert Process. One of these furnaces of 150 kilowatt capacity was constructed and worked under the author's supervision in Hohenlohehutte, Upper Silesia, with highly satisfactory results.

In order to design a satisfactory furnace it was necessary to keep certain points in view: The furnace must be gas tight; the temperature must admit of careful regulation; the construction must be rugged so as to stand severe usage; the heat losses must be reduced to a minimum since electrically generated heat is always expensive.

In Figs. 1 and 2 are shown respectively a longitudinal section and transverse section of the furnace with the cover removed. The walls of the furnace are double with air-spaces 1 which are designed to prevent the loss of heat by conduction through the walls. The furnace is provided with carbons T, T, C and C. The two former serving as terminals which are connected to the source of current by means of cable indicated by F and G, while the two latter are simply connector terminals which form the other terminals of the two sections of the resister R, R, and are connected by E. Bearing on the terminals T, T and the connector terminals C, C, are channels B, B which are connected with each other by the tensions rods S, S. The channels are, of course, insulated from the terminals. The furnace is lined with a suitable refractory M and is provided with a tap-hole at H. The resistor of the furnace is built up of a series of corrugated plates, which are illustrated in Fig. 3; the lower photograph showing an end view of the plate, while the above shows the shape in which the plates are cut as viewed from the front. In Fig. 4 is shown a view of the plates set up so as to form a resistor. Considering one of the plates it is to be noted that the thickness is not the same from top to bottom, but increases from the bottom up so that when put in place they form an arch of very long radius as shown in Fig. 4. Because of the interlocking of the plates this arch form is not necessary, but seems to be desirable in the preliminary assemblage and is also utilized to produce a somewhat greater current density along the lower surface of the resistor. The cover of the furnace, which is not shown

[1] Presented before the Congress of Technology at the Fiftieth Anniversary of the Granting of the Charter of the Massachusetts Institute of Technology.

in the illustration, carries feeding tubes by means of which the ore mixture may be fed into the bath below the resistor.

The peculiar construction of the resistor plates has two purposes; to give a sufficiently high resistance to the resistor and at the same time to form an interlocking device so that even if no arch form is given to the resistor yet it will not fall down. A furnace was built with plates having these dimensions: Length at top, 405 mm. 16 inches; length at bottom, 255 mm. 10 in.; width 165 mm. 6.5 inches. The two sections of the resistor contained 71 plates each. This when cold had a resistance of 0.200 ohm and when running at the full

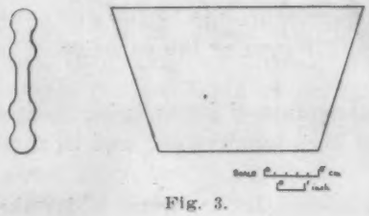


Fig. 3.

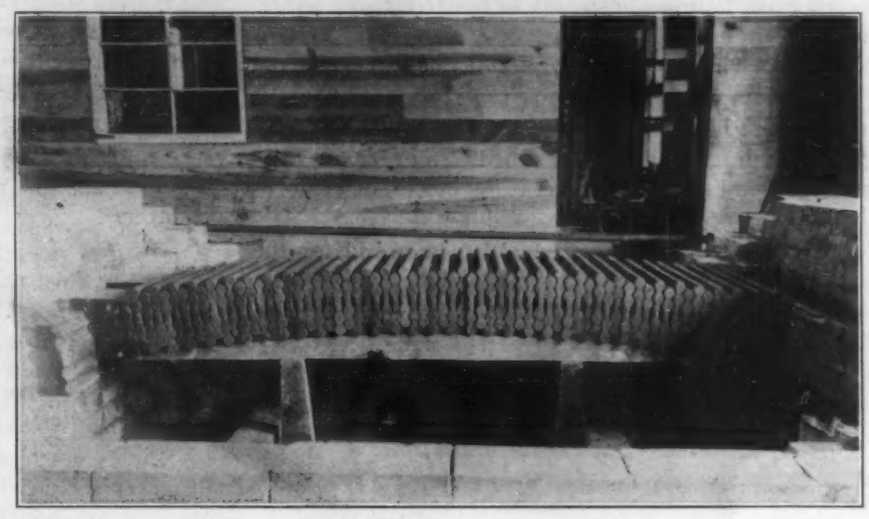


Fig. 4.

capacity of 150 kilowatts, and with a temperature in the furnace of 1400 degrees C., the resistance was 0.0375 ohm. This resistance is due almost altogether to the contact resistance between the plates, for by calculating the resistance of the carbon itself we find that it would not amount to more than 0.00064 ohm.

In order to regulate the rate of generation of energy in the resistor there must be some means of varying the voltage at the terminals of the furnace. At Hohenlohehutte, as well as in the FitzGerald and Bennie Laboratories where these furnaces have been worked, this is done by means of a transformer with several taps brought out from the primary coils which allow the voltage on the secondary circuit to be varied from 50 to 100 volts in 2.5 volt stops, and from 100 to 200 volts in 5 volt stops.

It will be seen that the weakest part in this furnace is the carbon resistor, due to the fact that if working in an oxidizing atmosphere the resistor will be destroyed. In the particular work for which it was designed, however, there would be no danger of this because the furnace is filled with vapor of metallic zinc. During the process of heating the furnace, or at any time when zinc vapors were not generated, there would be danger of burning through air leaking in; but this is easily overcome by keeping a reducing atmosphere in the furnace slightly above external pressure. It has been found by actual experiment that a furnace of this type running continuously for two months showed no appreciable wear of the resistor.

The regulation of temperature in this furnace is most satisfactory. In the Hohenlohehutte experiments thermo couples of pyrometers were placed in several parts of the furnace to study the temperature conditions carefully. It was found that the most accurate regulation of the temperature in the furnace was possible, the workman in charge adjusting the rate of generation of energy in the resistor so as to keep the needle of the pyrometer stationary.

The furnace is a highly efficient one. In one of the earlier models where the heat insulation was far from being satisfactory careful determinations of all heat losses were made. When working at temperatures between 1250 degress and 1260 degrees C. the total heat losses were 33 kilowatts, and when working at temperatures between 1400 degrees and 1450 degrees C. the heat losses were 42 kilowatts. Consequently when the furnace is working at full capacity, 150 kilowatts, the thermal efficiency at 1250 degrees is 78 per cent and at 1425 degrees C. is 72 per cent. No exact determinations of the efficiency of later models have been made, but it is known to be much higher than those given above.

The metallurgical end of the problem has not been completely worked out, but the satisfactory working of the furnace has been clearly demonstrated, and furnaces built on similar principles have been used experimentally with great success in the melting of aluminum, copper, brass, etc. This is thought to be of some interest, as a development in the use of electric furnaces using the heat generated by the passage of an electric current through a resistor. There is a tendency in electric furnace work to employ the arc which is often a mistake because of the difficulty in regulating the temperature. Finally, the furnace described above from its construction lends itself readily to adaptations which permit of using the combined heat effects of fuel and electricity, and it is thought that a great future is in store for furnaces of that type.

Electrical heating of water requires 110 watts to raise 1 quart from 60 to 220 degrees F., the boiling point. Immersion heaters have an efficiency of about 90 per cent.

ESSENTIAL FACTORS IN THE FORMATION OF PRODUCER GAS.

"Essential Factors in the Formation of Producer Gas" is the title of Bulletin No. 7, just issued by the Bureau of Mines. The authors, J. K. Clement, L. H. Adams, and C. N. Haskins detail an investigation of the chemical and physical processes that take place in the gas-producer in which they kept in view not only the possibility of increasing the efficiency of the producer as a source of energy and the ensuing benefits to the public of cheaper power and greater utilization of low grade fuels, but also the application of the results to the problems of boiler-furnace operations.

In experiments made by one of the authors at the Bureau's Experiment Station it was found that the temperature in the fuel bed of the gas-producer varied greatly in different parts of the bed. In order to ascertain the conditions of temperature most favorable to the efficient operation of the producer, it became necessary to determine the temperature required for the formation of carbon monoxide and hydrogen.

Among other reasons for investigating the conditions for the reduction of carbon dioxide by carbon was that a small quantity of carbon monoxide is invariably contained in the flue gases of boiler furnaces and it was hoped that means might be suggested of preventing its formation and the resulting loss in furnace efficiency.

These investigations demonstrated that a very high temperature is necessary for the production of carbon monoxide from carbon dioxide and carbon. These conditions, however, which argue against operating the fuel bed and the gas producer at extremely high temperatures—above 1300 C.

A very hot fuel bed means that the gases will leave the producer at a high temperature, and thus lower the efficiency of the producer. The gain in capacity would, therefore, be accompanied by a loss in efficiency, unless the heat of the gases could be used for generating steam or preheating the air blast. A high temperature also favors clinkering. In the application of the results of these experiments to commercial producers and furnaces it will be necessary, of course, to consider the other questions which are involved.

Various explanations have been suggested to account for the presence of small amounts of carbon monoxide in the flue gases of boiler furnaces. Perhaps the one generally accepted by engineers is that the oxygen of the air first unites with carbon to form carbon dioxide, and that as this gas passes up through the bed it combines with carbon in accordance with the equation $CO_2 + C = 2CO$.

Assuming this to be the correct explanation, then the questions to be solved are what conditions favor this reaction and what conditions will tend to retard it. It has been shown by the authors that the higher the velocity of the gas and the thinner the fuel bed the less will be the percentage of carbon monoxide formed. A heavy fuel bed in the boiler furnace would therefore favor the formation of carbon monoxide. Also, the greater the supply of air to a given depth of bed the less would be the percentage of this gas formed; therefore with a hot fuel bed the formation of a small amount of carbon monoxide is inevitable. In order that this carbon monoxide may be burned to carbon dioxide in some way sufficient air must be added to the hot gases as they leave the top of the fuel bed.

The bulletin also contains a chapter by J. W. Clement and L. H. Adams on "Effective Temperatures for Water-Gas Generation."

The results presented show that a high rate of gasification combined with a high percentage of carbon monoxide and a low percentage of carbon dioxide and water requires a high temperature in the fuel bed.

The higher the temperature the better will be the quality of the gas and the greater the capacity of the producer.

The use of large amounts of steam is inconsistent with the realization of high temperature, and is, therefore, to be avoided.

Although these investigations were undertaken primarily to determine the conditions governing the formation of producer-gas, the results have an important bearing on the water-gas process.

They show that although with very low rates of steam supply the decomposition of the steam may be complete at 1100 degrees C., with higher rates of steam supply, such as are desirable in practice, a much higher temperature, 1300 degrees or 1400 degrees C., is required to obtain complete decomposition. The highest efficiency will be obtained by raising the temperature of the bed during the blast as high as is possible without injury to the producer. As the bed cools during the run with steam, the steam should be gradually reduced, and when the temperature has dropped to 1000 degrees C., the steam should be cut off.

The bulletin is of a scientific character and will be of interest to engineers engaged in gas producer and gas engine work. Copies may be obtained by addressing the Director of the Bureau of Mines, Washington. D. C.

ELECTRICITY AND CROPS.

Professor J. H. Priestley, of Bristol University, England, in the course of a paper on "Electricity as a Factor in Crop Production," described in detail the numerous methods in which electricity has been either directly or indirectly utilized in the production of a crop, with a view to either accelerating or increasing the yield. In one particular instance the discharge of high tension electricity from overhead wires had resulted in an increase of 39 per cent in a field of wheat. He pointed out that while the precise effect of electricity on the physiology of plants was still in doubt, the three factors affected were the air, the plant and the soil. On one farm a network of electric wires was erected over various fields of wheat, while other fields, where the same kind of wheat was grown, were

left in their natural state. The electrified wheat gave a yield per bushel varying from 13 to 39 per cent in excess of the yield of the non-electrified wheat. In these experiments the tension was transformed 100,000 volts, the wires, however, carrying only 0·10 amp.

Exactly what the electrical discharge does is not clear, but Mr. Priestley claimed for it a tonic or bracing effect raising the tone of the plant and increasing the momentum of development. Miss Dudgeon, of Dumfries, has investigated the effects of the Cooper-Hewitt mercury-vapor lamp, and shows reason for believing that its blue-violet light helps plants grown under it to greater sturdiness. The leaf-cells in the treated plants show a markedly greater accumulation of green coloring matter or chloroplasm. Mr. Priestley fully endorsed the value of Miss Dudgeon's experiments. The light in question also, he thought, "increased the strengthening fibre" in the plants submitted to it. He said that Miss Dudgeon had found the Cooper-Hewitt mercury-vapor lamp "extraordinarily efficacious, producing accelerated germination, increased growth, greater depth of color, and, more important still, no signs of the lanky, unnatural extension of the plant usually associated with forcing." The following figures show how many days earlier Miss Dudgeon's seeds germinated under the lamp than in the control greenhouse: French beans, 8; carrot, 15; cauliflower, 20; lettuce, 6; oats, 5; barley, 5; wheat, 8. The lamp was 4 ft. above the seeds, and the light was turned on two hours daily after daylight.

The lecturer also described some experiments of his own at Bristol, in which he employed a quartz mercury-vapor lamp which, he found, permits many more of the ultra-violet rays from the luminous vapor to pass out into space, so that it is possible to study the effects due more particularly to these rays, and to institute comparisons between plants grown directly in the light and others grown behind the shelter of a glass, i. e., with most of the ultra-violet rays cut off. He found that in the case of mustard seeds the process of germination was enormously accelerated. Further, seedlings can be grown for some time close to the lamp itself, the plants developing being extraordinarily sturdy, and of quite a different shade of green from the normal ones. The effect of the quartz mercury-vapor lamp at close range is to retard or to entirely inhibit growth but, at great distances, or behind a glass screen, it has a marked accelerating and invigorating effect if used as complementary to ordinary daylight. One extraordinary result obtained was that in the case of the mustard seedlings exposed to the lamp at close range the plants are of an absolutely glabrous type, instead of, as usual, very hairy. The plants close to the lamp do not possess, either on stem or leaves, a single hair. Further away from the lamp hairs develop only upon the side away from the light, and shaded behind glass the plants are approximately as hairy as usual. Thus it is clear, said the lecturer, that light of a specific color properly controlled will enormously accelerate germination, a matter of profound importance for putting valuable crops on an early market. The same electric light helps the plants to robustness, a matter of great import with many valuable but only semi-hardy crops.

ALUMINUM WIRE FOR MOTOR FIELD COILS.

The International Street & Interurban Railway Association reports that twenty-five electric railway companies in Europe are employing aluminum field coils in their motors. The section of aluminum wire to provide the same amount of conductivity as copper must be 1.687 times as large at zero degrees C. or 1.645 times as large at 100 degrees C. The actual coil, however, is no larger, because it has been found possible to oxidize the surface of the aluminum wire so that no textile insulation is required. The weight of the coils is about 50 per cent to 55 per cent that of a corresponding copper coil. This weight amounts to about 250 lb. for a two-motor car. The cost is also lower, even including the value of the scrap, which is higher for copper than for aluminum.

Most companies use cambric, paper or other insulation between the different layers of the aluminum field coils, but none between wires composing the same layer.

Several methods are employed for oxidizing the wire in order to provide the non-conductive surface. One company, while the coil is being wound, moistens the cambric insulation between the coils and also the wire itself with the brush. When the coil is finished and before the outer insulation is put on a current is passed through the coil sufficient to raise the temperature of the wire to about 100 degrees C. The insulation resistance of the surface of the wire then gradually attains its normal value. Another company anneals the aluminum wire by raising it to a temperature of 200 degrees to 300 degrees C. before the coil is wound. Water is applied as before, but the coil is baked in an oven and the process is repeated once or twice. The General Omnibus Company coats the wire and coil with a plastic material having a clay base which gives a mummified coil.

In addition to the other advantages of the use of aluminum the maintenance of the coil is low because its lightness reduces the injurious effect of the jars to which these coils are subject. Care must be taken in winding to avoid joints in the wire, because it is difficult to make satisfactory joints, and care should be taken, when soldering on the field coil terminals, to avoid the formation of oxide on the surface of the aluminum wire.

DEFINITION OF AN ENGINEER.

In the course of an address before the Technical Publicity Association of New York, Barrett Smith of the Stone and Webster Engineering Corporation said:

"There are so many men with ordinary endowments doing work that enables them to pass as engineers because it is related to engineering, that the impression of the outsider regarding the profession of engineering is apt to be erroneous. By the same token, the impression of the education of which these workers are the product is apt to be erroneous.

"An engineer is a man who conceives a new system or arrangement of known elements, to meet conditions in a way that will confer some economic or industrial advantage upon his constituents, and then actually creates this system or arrangement. An engineering education simply develops this faculty and the judgment which goes with it."

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NOTICE TO ADVERTISERS

Changes of advertising copy should reach this office *ten days in advance of date of issue.* New advertisements will be accepted up to noon of Monday dated Saturday of the same week. Where proof is to be returned for approval, Eastern advertisers should mail copy at least thirty days in advance of date of issue.

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FOUNDED 1887 AS THE
PACIFIC LUMBERMAN, CONTRACTOR AND ELECTRICIAN

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Removing Short Circuits

L. C. Nicholson's startling method of removing a short circuit from a transmission line by shorting the generating station is like fighting fire with fire. As described by R. L. Mershon at the Los Angeles meeting of the A. I. E. E., quick-acting switches automatically short-circuit the station for five cycles when it is broken by expulsion fuses. This takes the voltage from the line and so clears the short.

The object of this method is apparently to prevent the system from being shut down or to avoid pulling the shorted line from the network. Where power is delivered to a system from one plant or from several plants tied together through transmission lines which join at points remote from any of the generating stations, this heroic treatment would seem practical, provided all apparatus in the power-houses is designed to withstand the ensuing strains. Where there are several plants it would be necessary to localize the break and exercise the Nicholson treatment through the plant directly connected with the trouble. The other plants would be unaffected except as they had felt the short-circuit. This all presupposes a short-circuit which will clear; that is, that there is no line damage whereby any wire of the circuit has fallen against another wire or the ground. Except to prove that it would not be of use, the system would be of no value in this latter case and would serve only as an indicator.

As to damage to instruments and apparatus in the power-house, every plant should be designed to withstand short-circuits, no matter where they may occur, and this might be near the power-house as elsewhere.

In the West several generating plants are often connected not only through the transmission network, but also connected directly to each other through a transmission line. Several circuits may also radiate in as many directions, each supplying a power district, and to still further complicate matters, they may be connected at other points with the network. Upon evidence of a short-circuit on one line, it is customary to immediately disconnect at both ends by the use of circuit-breakers. This saves other circuits and in most cases will not throw synchronous apparatus out of step. Much doubt has been expressed by operators if, in such systems, it would be wise to adopt the Nicholson plan.

Many of the Western plants do not use automatic controlling apparatus or even voltage regulators, and this plan has its adherents because a heavy short-circuit causing a tendency to lower line voltage and frequency will in most cases extinguish itself, causing no further damage than a momentary dip in lighting service and seldom throwing synchronous apparatus out of step. The personal equation enters largely in the methods of operation of complicated networks and it would probably take much demonstration under all of the many peculiar and unlooked-for conditions giving rise to the causes of short-circuits before the average operator would care to depend upon the proposed method of overcoming short-circuits.

PERSONALS.

C. E. Sloan is at Newman on engineering work.

Frank W. Eastman, representing Stanley & Patterson of New York, is at San Francisco.

H. B. Squeers, of the sales staff of Otis & Squires, San Francisco, is at New York City on business.

F. L. Robson, of the firm of Sloan & Robson, returned to San Francisco last Tuesday from Madeleine, Cal.

J. J. O'Brien, one of the vice-presidents of H. M. Byllesby & Co., of Chicago, left last week for the North.

H. R. Noack, of Peirson, Roeding & Co., returned to San Francisco last week from a Northern California trip.

B. M. Downs, vice-president of the Brookfield Glass Company, has returned East from the Pacific Coast via Seattle.

H. A. Wood returned to San Francisco during the past week, after a trip to San Diego on electrical engineering business.

W. W. Rockefellow, sales manager of the Western Electric Company, has returned to New York from a visit to the Pacific Coast.

Robert Carter, superintendent of the Coast Counties Light & Power Company, has returned to Santa Cruz after visiting San Francisco.

M. C. Miller, assistant to the president of the Allis-Chalmers Company, spent the past week at the San Francisco office of the corporation.

J. S. Cain, who has a controlling interest in the Hydro-electric Company which has rebuilt its power station near Bodie, is at San Francisco.

Leon M. Hall, who left last Tuesday for Carson and Reno, Nevada, will make some electrical engineering investigations in that part of the country.

F. G. Baum, of F. G. Baum & Co., returned to his San Francisco office during the past week, after making an engineering examination in the interior of California.

H. H. Hornsby, sales manager of the Sprague Electric Company's conduit and supply department, left last Tuesday for Portland, after spending some time in California.

R. S. Masson, chief engineer of the Electric Operating & Construction Company of New York, and general manager of the Arizona Power Company, is at San Francisco.

J. H. Thatcher. general manager of the Pacific Telephone & Telegraph Company with headquarters at Portland, recently returned to Oregon after paying a visit to the San Francisco office.

E. C. Bradley, general manager. and G. B. Bush. general commercial superintendent. of the Pacific Telephone & Telegraph Company, recently returned to San Francisco after a tour of the Pacific Northwest.,

George A. Damon, managing engineer for the Arnold Company, in charge of their work at Los Angeles, has been appointed dean of the school of engineering at the Throop Polytechnic Institute, Pasadena, Cal.

Norman Macbeth, formerly in charge of the illuminating engineering laboratories of the Welsbach Company, is now illuminating engineer of the Westinghouse Electric & Manufacturing Company and the Westinghouse Lamp Company.

L. H. Newbert, the present manager of the Pacific Gas & Electric Company's Redwood district, will, on June 1st, take charge of the new appliance department, with headquarters at San Francisco. To fill the vacancy caused by his appointment E. W. Florence, district manager of the Pacific Gas & Electric Corporation at Fresno, has been transferred to the Redwood district. W. H. Henderson. manager of the Colusa district. has been transferred to Fresno.

Chief Engineer Straubeck, of the Wailuka Plantation in the Hawaiian Islands, recently spent several days at San Francisco as the guest of W. Jamieson, first assistant engineer of the Merchants Exchange Building. Mr. Straubeck is on his way to Germany for a vacation.

R. L. Mershon left for the East last Sunday, after inspecting a number of electric power plants around San Francisco Bay. In company with A. H. Babcock, he visited the power station and repair shops of the Southern Pacific Company's new electric lines in Alameda County.

M. Takahashi, electrical engineer with the Ashio copper mine of Japan, is inspecting a number of hydroelectric power plants in California in the course of a tour around the world. Mr. Takahashi is making an especial study of transmission line practice and also of the application of electricity to mining.

Thomas Mirk, of Hunt, Mirk & Co., has returned from San Diego, where his firm has a large steam and electrical engineering contract with the San Diego Consolidated Electric Light & Power Company. A low-pressure turbine is to be installed in connection with a large reciprocating engine and generators.

OBITUARY.

Richard Spencer, formerly manager of the Los Angeles branch of the Western Electric Company and recently in charge of their Buffalo house, died at Danville, N. Y., on May 6, 1911.

Peter J. Lynch, who died at Seattle May 1st, after an illness of only two days, was the district superintendent of the Pacific Telephone & Telegraph Company in the Puget Sound territory. He was well liked in California, where he held various official positions with the company for twenty years. He was superintendent at Oakland for several years and for one year acted as manager of the Philippine Telephone & Telegraph Company with headquarters at Manila. Mr. Lynch was aged forty-one years and left a wife and one daughter.

MEETING NOTICES.

The May meeting of the San Francisco Section of the American Institute of Electrical Engineers will be devoted to an inspection of the new Fruitvale power plant of the Southern Pacific Company. The meeting will be held on the evening of May 19th.

The thirty-fourth convention of the National Electric Light Association will be held in New York city, opening on May 29th and continuing until June 2d. The convention will, without question, be the largest in the point of attendance yet held by the organization. The remarkable success which has attended this association is well merited. It has done more for its industry than any other industrial association in this country. Through the interchange of ideas at its conventions rates have been universally reduced, service improved and a better understanding secured with the public. According to Secretary T. Commerford Martin the growth in membership during the past year has been large.

At the meeting of the American Society of Mechanical Engineers in New York, on May 9th, several important papers on the subject of patents were presented and discussed by E. W. Marshall, D. H. Haywood and E. J. Prindlow. At the spring meeting of the society, to be held in Pittsburg, Pa., May 30th to June 2d, cement manufacture will be one of the principal subjects considered. Among the other papers to be presented are "Commercial Application of the Turbine Turbo-Compressor," by R. H. Rice; "Purchase of Coal on the Heat-Unit Basis," by Dwight T. Randell; "Energy and Pressure Drop in Compound Steam Engines," by F. E. Cardello. There are also to be sessions on Gas Power, Machine-Shop Practice and Steel-Works Practice.

ELECTRIC RAILWAY DICTIONARY.

An Electric Railway Dictionary has been compiled by Rodney Hitt under the direction of a committee appointed by The American Electric Railway Association and published by the McGraw Publishing Company of New York. This is a step towards standardizing the nomenclature of electric car construction. It is arranged in two sections, the first giving an alphabetical list of definitions and the second a logical presentation of illustrations. This volume of over four hundred 9 x 12 pages, while intended primarily for electric railway men, should be of interest and value to every electrical engineer.

NEW CATALOGUES.

Thomas & Betts have given their line of boxes, locknuts and checknuts to Otis & Squires for the Pacific Coast.

The General Electric Company has just issued Bulletin No. 4820, which supersedes its previous bulletin on Curve Drawing Ammeters and Voltmeters.

Catalogue No. 25 from the Chicago Fuse Mfg. Co. is devoted to Stamped Steel Switch and Outlet Boxes, giving illustrations, dimensions and prices.

Fancleve Specialty Co., Jamaica Plain Station, Boston, Mass., have issued a complete catalogue of fittings for metal and wood moulding, armored cable, conduit and miscellaneous uses.

Railroad electrification is the subject of Circular No. 1517 from the Westinghouse Electric & Mfg. Co., giving illustrations and descriptions of a number of foreign and domestic electric railway installations.

The General Electric Company has just issued an attractive pamphlet entitled, "Charging the 'Electric' at Home." This pamphlet describes briefly that Company's Mercury Arc Rectifier as used for charging the batteries for electric runabouts.

The New York & Ohio Company, of Warren, Ohio, are issuing two illustrated folders, one giving a revised price schedule, and the other a revised discount schedule for the "Packard" incandescent lamps.

Allis-Chalmers Company have issued Bulletin No. 1622, in which is given a description of the Manhattan High Pressure Fire Service System, together with some of the results which have been attained with its use.

Bulletin No. 4799, recently issued by the General Electric Company, illustrates and describes in considerable detail several types of revolving field alternators manufactured by this company. Both horizontal and vertical shaft alternators are illustrated.

"Westinghouse Static Protective Apparatus," Folder 4110, is an attractive little publication recently issued by the Westinghouse Electric & Manufacturing Company, East Pittsburg, Pa. This folder, as the name implies, covers the line of static protective apparatus as manufactured by the Westinghouse Company.

Chas. C. Moore & Co., engineers, are distributing a handsome leather-bound memoranda book with renewable insert. Each sheet is perforated so that it may be easily torn out in part or in whole as the note has been properly attended to. This feature makes it particularly valuable to the engineering fraternitiy for whose use it has been especially designed.

The General Electric Company has issued an attractive bulletin, which illustrates and describes its Electric Fans for the coming season. These fans are made for either alternating or direct current, and in various styles and sizes to meet various conditions. The publication lists fans suitable for the home, office, and restaurant, and fans which can be placed on desk or table, or fastened to the wall or ceiling. The bulletin, which is No. 4806, lists also various small power motors.

The General Electric Company reports a contract for the season's requirements and an initial order of 5004 Calorite Leaf Unit flat iron, equipped with the "external spring" attachment plug, from H. M. Byllesby & Co., for their various properties. Also another order for 6000 flat irons of the same description from the Southern California Edison Co., of Los Angeles and vicinity.

Bulletin No. 4822, just issued by the General Electric Company, illustrates and describes its GE-98 railway motor, which was designed to meet the demands of heavy city and suburban service, and is suitable for either two or four-motor equipments. The motor is rated at 50 h.p. The publication contains dimension diagrams, characteristic curves and a table of schedule speeds.

TRADE NOTES.

The Kellogg Switchboard & Supply Company has closed a contract with the Farmers' Telephone Company of Omak, Wash., for complete central office equipment for the system.

The Westinghouse Electric & Manufacturing Company, Pittsburg, Pa., has just received a contract from the British Columbia Electric Railroad, of British Columbia, for two 45-ton locomotives with quadruple equipments of No. 301 interpole railway motors and automatic unit switch control.

The salesmen of the Kellogg Electric & Supply Company are distributing a unique paper match holder. Each match is labeled with the name of an apparatus type. On the reverse side of the folder is given the company name and the principal types of apparatus manufactured. Small cases in variously colored leathers hold these match folders, making an attractive advertising novelty.

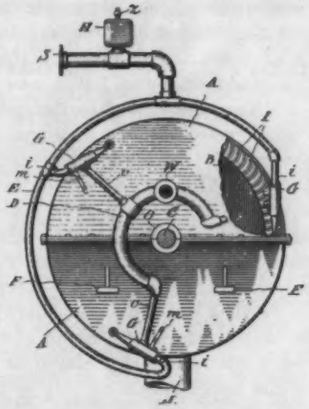
The Pelton Water Wheel Company has been awarded a Government contract for all of the hydraulic work and equipment for the new power plant near Fallon, Nev., in connection with the Truckee-Carson project. The contract covers two double-discharge Pelton-Francis turbines (spiral case type) of 830 h.p. each, to operate at 514 r.p.m. under a head of about 105 feet of water. Pelton oil pressure governors and Pelton relief valves, of special design, will be used.

The Cutler-Hammer Mfg. Co. announces the establishment of a new department to be devoted exclusively to the design and manufacture of electrical appliances for industrial heating. The resources of the company's large and thoroughly equipped New York factory will be principally devoted to the manufacture of this class of apparatus, under the direct supervision of Mr. W. S. Hadaway, Jr., who for many years has specialized on applications of electric heat to industrial purposes.

The Washington Water Power Company have just placed an order with the General Electric Company for two of the largest waterwheel driven generators ever constructed for their Long Lake plant. These will be three-phase generators of the horizontal type and will have a capacity of 13900 k.v.a. and will be of so liberal design as to be able to carry a 25 per cent overload continuously. They will operate at a speed of 200 r.p.m. and will generate current at a potential of 4000 volts. Four of these generators will eventually be installed at this plant. They are driven by I. P. Morris horizontal twin turbines each of 22,500 capacity at full gate, operating under a head of 170 feet. These are the largest waterwheels that have ever been constructed. The dam is 183 feet high at the deepest section and is the highest spillway dam that has ever been constructed. The potential of the transmission line will be 60,000 volts for the present, although the plant is designed for 110.

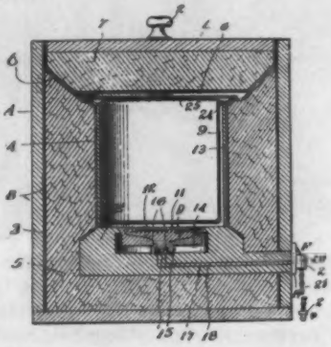
PATENTS

991,074. Compound Hydro-Steam Engine. David Maclean, Calexico, Cal. In a compound hydro-steam engine having several injectors connected to a steam line, which project their several jets of water directly upon the first series,



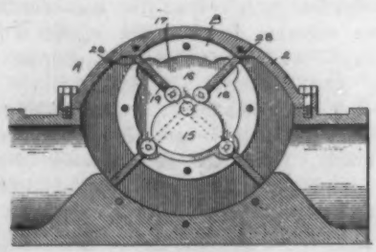
of a plurality of series of buckets combined with a segmental drum and a frame within which the several series of deflectors are attached.

990,927. Electrically-Heated Cooker. Charles E. Terwilliger, Santa Cruz, Cal. A cooking device of the class described comprising a casing, inner and outer shells disposed therein, a heat retaining filling between the shells, a cooking utensil within the inner shell, a heating element under the



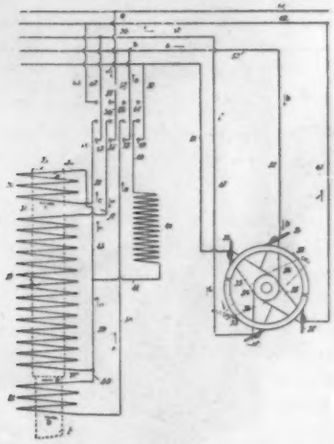
utensil, a chambered holder of non-conducting material disposed at the bottom of the inner shell and containing the said element, conductors embedded in the said holder for supplying current to the heating element, and a fuse device mounted on the casing and connected with the said conductors.

991,314. Rotary Pump. Ira Boyd Humphreys, Denver, Colo. In a rotary pump, the combination with a casing, of



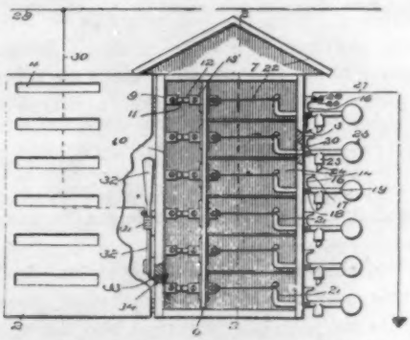
having slots therein, double blades received in the slots, webs connecting the blades of each double blade together, a runner mounted in the casing made in sections, said runner one section of said runner having a passage for the webs of the blades, a chamber formed between the ends of the two sections, a stationary shaft, and a cam on the stationary shaft received in the chamber, adapted to engage the inner ends of the blades and force them outwardly.

991,384. Electric Reciprocating Engine. William Armor Stedman, Millers, Nev. An electric reciprocating engine comprising a solenoid having a series of distinct superposed section windings, the middle winding being connected in series with each of the end windings; an operating electric circuit suitably connected with an electric source embodying said middle winding and one of said end windings of said solenoid; an independent electric circuit embodying a resistance coil and connected with the inactive end coil of said



solencid; a supporting frame for said solenoid; a rotary switch having a plurality of curved metal sectors, a rotary switch having a plurality of curved metal sectors cylindrically arranged and adapted to be rotated; a plurality of brushes adapted to electrically contact with said sectors, said brushes forming the terminals of the said operating and independent circuits; and means for adjusting the said terminals to vary the relative distances between the said terminals to effect a prolongation of the circuit closure in one of the said end windings.

991,372. Automatic Fusible Lightning Arrester. Andrew Reid, Colorado City, Colo. In a lightning arrester, a housing, a plurality of fuses, a pivotally mounted weighted lever connected with one end of each of said fuses, means for connecting said fuses with a line wire, and means for connecting

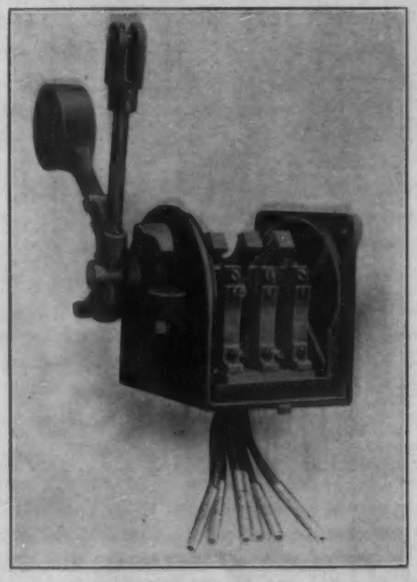


said levers to the earth, said means including a wire, a bracket pivotally connected with each of said levers, and a contact member connected with each of said levers arranged to engage said brackets respectively as said fuses are broken.

INDUSTRIAL

AN AUTOMATIC FLOAT SWITCH.

An automatic float switch of new design has recently been placed upon the market by the Westinghouse Electric & Manufacturing Company. The new design embodies several features that recommend it highly for the control of motors driving pumps that empty into reservoirs, on drain sumps, sewers, etc. The operation of the switch is entirely automatic and the mechanism requires no attention beyond an occasional inspection and oiling. The switch is operated by a cylindrical steel float which plays between brass stops on a vertical rod, as illustrated; the stops are adjusted to the upper and lower water levels. When the float presses against either stop, a U-shaped tripping lever attached to the float-rod engages a pivoted weight-arm and carries it



Automatic Float Switch.

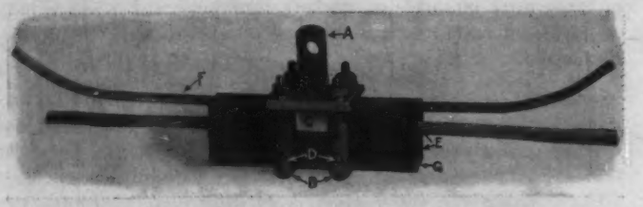
upward and around past the vertical position. The weight-arm then falls, engages an arm on the switch drum shaft, and snaps the switch open or closed, according to the direction in which the weight-arm is thrown. A buffer receives the force of the weight-arm's fall. When the float-rod is attached to the tripping lever, the pump will be started when the float presses on the lower stop and hence is properly arranged for filling reservoirs. With the rod attached to the other side of the lever, the switch is adjusted for drainage purposes, as the motor will be started when the float presses against the upper stop. The switch is of the drum type with renewable contacts and fingers.

The float and float-rod are heavily galvanized and are enamelled and baked. This finish effectually prevents rust. The standard float-rod permits maximum variations in level of six-feet.

These switches are made in two styles—double-pole for direct current, and single-phase alternating current motors, and three-pole for polyphase motors. The maximum capacity of these switches is 50 amperes at 550 volts. The motor is connected directly across the line and hence can be used only with motors that do not require starting voltage.

A NEW SUSPENSION CLAMP FOR HIGH TENSION CONDUCTORS.

In the transmission of high tension electric currents using suspension type insulators, it is common practice to use stranded conductor either of copper or aluminum. In order to suspend the conductor from the lower unit of each series, a clamp of some form is used. Heretofore, most of the clamps were made of metal but a new design, invented by Mr. R. A. Willson, General Superintendent of Railways, Washington Water Power Co., of Spokane, Wash., and used with great success on their transmission lines since their construction early in 1910, makes use of two wood clamping blocks in place of the metal clamps as ordinarily used. One of the chief advantages of this clamp is that, the wood being soft to a certain degree, the clamping members will not injure the cable. This is especially advantageous where aluminum cable is used, as it is well known that aluminum cable can be seriously injured by being clamped too tightly. Referring to the illustration, the clamp is attached to the clevis casting of the lower insulator unit by means of the sus-



Wooden Suspension Clamp for High Tension Insulator.

pension member "A," which is attached to the clamping members "E" by means of the U bolts "B." Grooves are provided at the top and bottom "G" of the clamping members for the insertion of arcing horns or rods. The illustration shows the arcing rod "F" placed at the top where it is ordinarily used. In order to prevent destruction of the clamp or cable by a flash-over, the arcing horn is electrically connected to the cable by means of the aluminum strip "C." The screws "D" are for the purpose of facilitating the assembly of the clamp on the line as they prevent the members from dropping apart. The clamp is pivoted at "A" so that breaking of the conductor will allow the clamp to swing, thus preventing kinking of the conductor. The clamp is somewhat more expensive to produce than some other designs, but the results in service seem to abundantly justify the expenditure.

Mr. Willson has made arrangements with The Ohio Brass Company of Mansfield, Ohio, to manufacture and market this clamp.

DATA ON DECORATIVE STREET LIGHTING.

"The Illumination of the Streets" is the title of a brochure just issued by the Holophane Company. While intended for popular distribution rather than for engineers, the booklet contains some valuable data on the subject and should be appreciated by all who are interested in the so-called "boulevard lighting" installations.

The Holophane Company's street lighting units have several definite advantages over other equipment, according to the data given. The units are the result of a long series of investigations and experiments by the Holophane engineers, and are designed to give the maximum of even illumination upon the streets and sidewalks with the minimum of objectionable glare. The comparative photometric curves published would indicate that the units are successful in both directions.

Artistic appearance, however, has not in this case been sacrificed to engineering considerations. The Holophane units are especially attractive and the various designs have a wide range or adaptability. A sketch of a lantern for residential districts strikes a new note in street lighting equipment, while even the standard shapes for the lighting of business thoroughfares have an air of distinction quite unusual.

In view of the great interest everywhere manifested in improved street lighting, this publication of the Holophane Company comes at an opportune moment and should prove of more than passing interest.

MOTORS, CONTROLLERS AND RESISTANCES FOR ELECTRIC VEHICLES.

In order to meet the requirements of automobile manufacturers the General Electric Company's motors for electric vehicles are made in six sizes, which cover all classes of service from the runabout, speedy roadster and light delivery, to the 3 and 5-ton trucks.

They are designed for single-motor drive through counter shaft with double-reduction chain transmission. This design saves weight, space and cost, and gives high rotative speed which insures electrical efficiency. It also conserves the battery, thereby increasing the possible mileage, and permits the mounting of the motor on the chassis well up from the ground.

The mechanical construction is very simple. The frame and one head is made from a single piece of cylindrical steel casting, machined from end to end, thus combining minimum

Motor for Electric Vehicles.

weight with maximum strength. The heads are fitted with improved annular ball bearings, which increase the efficiency, reduce the overall length of the frame, and require only occasional lubrication. Furthermore, in order to facilitate repairs, the form of the construction adopted permits the removal of the shaft without disturbing the commutator or winding.

Liberal electrical factors permit operation at high overloads for considerable periods of time without injury. The commutators have a large number of bars, and special graphite brushes of large area render the current per square inch of brush contact lower than that usually obtaining in electric motor practice. This is important where a storage battery is the source of power.

Since a suitable controller is fully as important as a proper motor for the satisfactory operation of electric vehicles, all automobile controllers made by the General Electric Company embody the continuous torque principle. This design insures freedom from jolts due to opening of circuit in passing from series to multiple connection of field coils, thus enhancing the pleasure of operating the smaller vehicles, and adding to the life of large trucks.

With single motor equipment, series-parallel arrangement of fields is the standard form of control, resistances being used on intermediate steps. The controllers for pleasure vehicles are provided with a comparatively large number of points, to permit of running slowly through traffic congested city streets, or at higher speeds over park and country roadways. This fine gradation of speed is not required in the case

Controller for Electric Vehicle Motors.

of commercial trucks, however, and their controllers have only a sufficient number of notches to safeguard the chain or gearing of the transmission.

The latest design of controller is of the cylindrical drum type, operated by a pinion and sector at one end. The sector is mounted on a countershaft which carries the operating lever or handle. The drum contacts are made of drawn copper tubing screwed in place on a treated wood frame. Horn fibre spacers are inserted to insure smoothness of operation and to prevent sparking. The contact fingers are of rolled copper stock, secured to phosphor bronze springs. The controller is designed throughout to withstand rough usage, and many of the parts can be used for different systems of connection. The operating handle is made from drop-forged steel, and can be formed to suit the requirements of the various makes of automobile, as to shape of seat and body outlines.

Cast-Iron Grid Resistance for Electric Vehicles.

The resistance provided is of the cast-iron grid resistor type, universally recognized as the most suitable for electric vehicle service. It is of sturdy construction, heavily insulated with mica, and provided with drop-forged terminals. All terminals, leads and contacts of each component part are marked with letters corresponding to those on the wiring diagram furnished, so that the necessary connections can be made properly by those who do not possess special electrical knowledge.

The Davis & Farnum Mfg. Company, of Waltham, Mass., have been awarded contracts for the erection for the Pacific Gas & Electric Company of a 100,000 cubic ft. gas holder at Chico, and a 150,000 cu. ft. gas holder at Petaluma. They have just completed the building of a holder at Oroville, for the Oro Water, Light & Power Company.

NEWS NOTES

FINANCIAL.

ONTARIO, CAL.—The remaining $80,000 of the $175,000 water bond issue of which $95,000 were sold December 5, 1910, have been sold to the Ontario National Bank, at a premium of $3775. The next highest of seven bids offered was that of Wm. R. Staats, Los Angeles. for $3710.

SAN FRANCISCO, CAL.—The $238,000 6 per cent Stockton Water Company bonds, which matured April 1, 1911, have been redeemed as fast as presented, and only a very small portion of the amount have not been taken up. As soon as these are presented, the mortgage will be cancelled.

ORLAND, CAL.—Bonds for the sum of $50,000 for the municipal water and sewer systems carried at the election held in this city by a vote of 123 to 3 for the bonds. It is proposed to use $25,000 of this sum for the construction of a sewer system and the balance for a municipal water system.

SAN FRANCISCO, CAL.—By a compromise between the gas company and the Board of Supervisors it has been agreed that the gas rate litigation, which has been in the Federal courts for three years, shall be settled by the equal division of the impounded 15 per cent and the establishment of a rate of 85 cents and 80 cents for the year beginning in July.

KLAMATH FALLS, ORE.—The properties of the Klamath Falls Light & Water Company, of Klamath Falls, Ore., have been purchased by the Klamath Falls Power Company, the transaction involving about $500,000. The purchase includes two plants in Klamath Falls, the transmission lines throughout the city and those extending to several towns about 25 miles away. The company is said to be a subsidiary of the Siskiyou Electric Light & Power Company, of Yreka, Cal., which was recently denied a franchise for transmitting energy to Klamath from its station on the Klamath River, about 20 miles distant.

SANTA BARBARA, CAL.—At a recent meeting of the directors of the Santa Barbara Gas & Electric Company it was decided to ask stockholders to ratify a bond issue of $1,000,000. The new bonds are to bear 6 per cent interest, the plan being to substitute them for the 5 per cent issue of the same amount which it has been found difficult to float. This plan will not increase the bonded indebtedness of the company, and will offer a more attractive bond to investors. At present $680,000 of the 5 per cent bonds are held as security for loans. The 5 per cent bonds will be called in as soon as the 6 per cent issue is placed on the market.

BAKER CITY, ORE.—A. B. Sterns, City Clerk, will receive bids until 5 p. m., the 29th of May, for improvement bonds of the City of Baker, Oregon, the total amount of the issues being $140,000, issued in amounts of not less than $500 each, to be issued for the improvement of the city water system in the sum of $90,000; for the construction of new reservoir in the sum of $25,000, and for paving of street intersections in the sum of $25,000. Bids must be separately made for each of said issues and may be for the whole or any part of. Each of said bonds is to bear date of July 1, 1911, payable 20 years from its date and will bear interest from said date of issue. Each bid to be accompanied by a certified check, payable to the mayor in the sum of 5 per cent of the amount of bid.

SAN FRANCISCO, CAL.—The sale of $1,110.000 worth of the Hetch Hetchy water bonds by Treasurer McDougald at par over the counter has been authorized by the Supervisors. The offering is the amount for which no bids were received in April, and the money realized from their sale is to go for the construction of the Lake Eleanor dam, the building of about 80 miles of roadway, later to be used largely for the conduit line. and other work in the mountains. The sum of $10,000 was appropriated for the use of the city engineer in carrying on the survey and preliminary work around Lake Eleanor, and $5000 for the use of the city attorney in presenting the city's case before the board of army engineers on the question of revoking the Hetch-Hetchy portion of the Garfield grant.

INCORPORATIONS.

LOS ANGELES, CAL.—The Los Angeles Electric Vehicle Company has been incorporated with a capital stock of $200,000, by S. Hendricks, P. L. Lindley, W. L. Crawford, C. E. Nestor and J. A. Lighthipe.

CHELAN, WASH.—The Rubin Electric Power & Lumber Company, capital $500,000, has been incorporated by Wm. H. Schokel of St. Paul, Minn., Chas. Rubin, of Chelan. The latter is superintendent and manager.

SAN FRANCISCO, CAL.—Articles of incorporation of the Sacramento & Folsom Railway Company have been filed. The road is to embrace a distance of twenty-two miles and has a capital stock of $1,000,000, of which amount $26,000 is paid up. The directors are Francis V. Keesling, Herman H. Grau, Ernest L. Brune, J. W. Cook and K. Grau.

SAN ANDREAS, CAL.—Articles of incorporation of the Sacramento Power & Water Company have been filed here. A part of the scheme is to provide Calaveras, Sacramento, Amador, El Dorado and other counties with water. The incorporators are: Charles Chapman of San Francisco, Charles Barsotti of San Andreas, John Muldoon of Berkeley, Dudley Smith of Oakland, and C. J. Lancaster of Alameda. The capitalization is $2,500,000, of which each director has subscribed for $500 worth of stock.

VALLEJO, CAL.—Amended articles of incorporation of the Vallejo & Northern Electric Railroad, showing an increase of capital stock from $2,500,000 to $10,000,000 have been filed with the Secretary of State by Melville Dozier. Report has it, however, that when the Vallejo and Northern increased its capital stock it had the sole view of building its road up the Sacramento Valley from Vallejo to meet the Northern Electric. This will give the latter road a valley and water route to San Francisco The proposed extension will bring the road to Sacramento by way of Suisun and Woodland. A branch of the road is now operating from Vallejo into the rich Napa Valley.

TRANSMISSION.

MARCUS, WASH.—This place has accepted the offer of H. V. Gates of Hillsboro, Ore., to furnish Marcus with an electric lighting system.

NYSSA, ORE.—The Kingman colony is having surveys made for an electric plant on Snake River. The project is intended to cover 5200 acres.

SEATTLE, WASH.—The Council has authorized an expenditure of $75,000 for the construction of a new power plant on Lake Union at the foot of Nelson Place. The plant will be operated by water power and will generate 2000 h.p. daily.

HOOD RIVER, ORE.—The Pacific Power & Light Company is making preparations for improvements. A power line is to be extended to The Dalles. No. 4 copper wire will be used. It is announced $1,000,000 will be expended in these improvements.

ELMA, WASH.—The Olympia Railway & Power Company has asked for a franchise to erect poles and wires in the streets for the purpose of furnishing light and power.

ROSEBURG, ORE.—The plant 3 miles north of Roseburg which supplies the city with water and electric power and light was destroyed by fire. Loss $50,000. Kendall Bros., Pittsburg, Pa., owners.

NEZ PERCE, IDAHO.—President Z. A. Johnson of the Nez Perce & Idaho Railway, owner of the Nez Perce power and light plant near Greer, is contemplating developing the power site to its full capacity, 1500 h.p.

LEWISTON, IDAHO.—The Lewiston-Clarkston Improvement Company has been granted a franchise to supply this place with electrical current for heating, lighting and power purposes. Harry L. Powers is manager of the company.

PLACERVILLE, CAL.—Henry A. Meyers has filed a notice of an appropriation of 15,000 miners' inches of the water of the middle fork of the Cosumnes River. The announced intention is to store all the water in excess of a flow of 5000 inches in a reservoir to be made by the construction of a dam 100 feet high across the Middle Fork of the Cosumnes River. The purposes of the appropriation are to generate electric power and to furnish water for irrigation near the town of Plymouth. The proposed reservoir will store an amount of water equivalent to a flow of 400,000 inches for 24 hours.

SAN FRANCISCO, CAL.—A rumored disagreement in matters of policy between the officers of the Great Western Power Company was reported in recent press dispatches from Oroville as the cause of the recent resignation of H. H. Sinclair as vice-president of the company. This rumor Mr. Sinclair denies in a communication just made public, explaining that his relations with the other officers and directors of the company are very pleasant, and that while the demands upon his time made by personal interests in Southern California necessitated his resignation as manager he will, at the request of the directors, supervise the large amount of construction work for which the company recently set aside nearly $2,000,000. This extension of the company's power system is made necessary, Mr. Sinclair explains, by the rapid expansion of the business of the company, especially since its entry into the distributing field in San Francisco.

TRANSPORTATION.

MODESTO, CAL.—At last the protestants against the granting of a franchise to the Tidewater & Southern Railway, on Ninth street, in this city, have come to an agreement with the railroad people on every provision of the franchise ordinance before the Board of Trustees, and the ordinance will be passed at the next meeting.

SACRAMENTO, CAL.—A deed just executed is said to pave the way for the early building of a street railway through Elmhurst by the Sacramento Electric, Gas & Railway Company. The property was transferred from Louis F. Breuner to H. A. McClelland, who placed Elmhurst on the market. Permission was also obtained, it is stated, whereby the car-line will be allowed to cross the S. P. Co.'s tracks. The extension of the car system will cost about $15,000

SACRAMENTO, CAL.—The Sacramento Electric, Gas & Railway Company will soon submit a new ordinance to the Trustees, asking for a "cross-town" franchise. The "cross city" line will begin at Fifteenth and I streets, thence on Fifteenth to K, thence on K to Twenty-first, and on Twenty-first to P. Not only will this line place the Western Pacific depot in direct touch with the hotel district by street cars, but will also give street car connection with the depot from the junction of lines in the southern part of the city at M, P, T and Twenty-first and Fifteenth streets.

SAN FRANCISCO, CAL.—The City Attorney has advised Mayor McCarthy that the municipality can proceed at once to the construction of the greater part of the city road on Geary street despite the pending litigation involving part of certain sections; also that the city authorities have the right to deviate from the original route described in the bond issue ordinance; and finally, that when the city desires cessation of the operation of the company now running cars on Geary street under temporary permit from the municipality, all it has to do is give notice, and if the company does not within the time allowed remove its rails, the city may do so itself, turning them over to the company when it sees fit to do so.

OAKLAND, CAL.—The completion of that portion of the Oakland & Antioch Electric Railway project between Walnut Creek and Oakland for the construction and operation of which a two-million-dollar bond issue was recently authorized, is practically assured, through the formation by a strong group of New York capitalists of an underwriting syndicate. Sufficient money has already been subscribed to warrant the engineering firm of J. G. White & Co. The contract calls for a rock-ballasted road, with heavy electric welded track, the signing of a construction and supervision contract with the total mileage being 17½. It is understood that a profitable freight traffic is assured, contracts for the handling of lime and wine on a large scale having already been signed. The road will traverse a picturesque country, and with stage connections to Mt. Diablo pleasure travel is expected to add to the traffic from the San Ramon Valley to Oakland and San Francisco via the Key Route, with which the Oakland and Antioch has an operating agreement.

OAKLAND, CAL.—The work of electrifying the Seventh street local lines of the Southern Pacific Company was begun Saturday, when 400 men started constructing the additional track which must be laid between East Oakland and Melrose. The new electric system will necessitate relaying of practically all the track in East Oakland. General Roadmaster Corrigan of the Western division has taken personal charge of the first section of the work, as all the local and main-line trains running out of First and Seventh streets, have to be kept on schedule time during the course of the reconstruction of tracks. From a point located near the foot of Tenth avenue, through to Melrose, four tracks will be laid. The two tracks next to the bay will be used exclusively by main-line trains, while the others will be maintained for local traffic. At Tenth avenue the main-line tracks swing over to First street, while the local branch into Seventh street. The entire Seventh street system will be reconstructed without disturbing the steam-train service. The remodeling of the lines in Alameda for the electric system is practically completed, but a few more days of work remaining before trains can be operated on both lines. In Berkeley, too, the work is nearly done, but this portion will have to await the completion of the Oakland division before being changed into the new service. The work on Webster street will take but a short time, as only one track is used at any time, and there is but a short strip of road to rebuild. As fast as the construction parties lay track on the Oakland system the electrical department will set poles and finish the work. The entire broad gauge system is being held back on account of the Seventh street line, due to the delay incurred in securing the franchise. From 400 to 1000 men will be kept busy from the present time until the whole work is complete.

ILLUMINATION.

LOS ANGELES, CAL.—The Board of Supervisors has voted to accept the bid of the Thos. Day Co. of San Francisco, $13,360.26, for furnishing electrical fixtures for lighting the Hall of Records building.

ALAMEDA, CAL.—An estimate for the cost of reconstructing the municipal light plant has been made by the

electricity commissioners, showing the total cost for the proposed improvements to be $123,700.

TWIN FALLS, IDAHO.—The Council has passed an ordinance granting to W. W. Seymour and F. C. Brewer the right to maintain and operate gas plants and lay mains and pipes for the purpose of distributing gas over the city.

OREGON CITY, ORE.—A. L. Beatie has presented to the Council a gas franchise for which he made application to run 25 years. This was read the first time and on motion of Mr. Meyer referred to the finance committee and the city attorney.

LOS ANGELES, CAL.—The Board of Supervisors will receive sealed bids up to 2 p. m., May 29, 1911, for a franchise granting the right for a period of 40 years, to lay, construct and maintain a system of gas pipes under and along the public roads and highways of Los Angeles county.

WILLOWS, CAL.—The Northern California Power Company is about ready to begin the erection of a building over its new gas plant, near the water tower. The building will cover the tanks, holders, containers and machinery of the plant. It will be built of sheet iron. The laying of mains is now going on.

VANCOUVER BARRACKS, WASH.—The bids for furnishing electricity to the government in this post were opened, the bid of the Mount Hood Railway & Power Company, of Portland, being the lowest. A 75 horsepower motor to pump water for the post will be installed and will run 24 hours a day.

ORANGE, CAL.—The Southern Counties Gas Company, through its representative, A. I. Stewart, has requested the City Council to offer for sale a gas franchise in the City of Orange. Mr. Stewart states that a high pressure line will be laid at once. Orange will be first to get the line, being nearest to the supply plant. The franchise proposed calls for 50 years, which was objected to somewhat by the trustees.

MONROE, WASH.—At the last meeting of the City Council the petition of the Everett Gas Company, of which H. H. White is representative, was read and referred to the ordinance committee. Mr. White agrees to start work immediately upon the granting of a franchise and extend the main from Snohomish to this city.

PORT TOWNSEND, WASH.—The Western Steel Corporation, with principal place of business in Seattle, has made application to the Board of County Commissioners of Jefferson County, to grant to it a franchise for a period of 50 years to construct and operate a system of gas mains and pipes and a system of electric wires for the transmission of electric current.

WATERWORKS.

BEND, ORE.—The Common Council has granted a water franchise for the Lytle Addition to Steidl & Tweet.

WINLOCK, WASH.—Steps are now being taken by the Winlock taxpayers for an adequate water system for the city.

MEDFORD, ORE.—The Jacodson-Bade Company has been granted an additional contract by the City Council for the laying of water mains on E. Main, Roosevelt and Queen Anne streets.

SEATTLE, WASH.—The Board of Public Works has awarded to the Jahn Contracting Company, in the Leary Building, the contract for the Grand Boulevard water mains for $16,408,60.

COULEE CITY, WASH.—The County Commissioners have granted a franchise to the Northwestern Improvement Company, a right to lay mains, operate and maintain a water system in the town of Wheeler.

MODESTO, CAL.—Water Inspector Davis and City Clerk Thompson have been authorized to get bids on 600 ft. of 8-inch and 1500 ft. of 4-inch waterpipe for extensions to the West Side park and in other suburbs.

ILO, IDAHO.—The City Council has decided that Ilo must have fire protection and has ordered two of its members to prepare the necessary plans to begin the construction of waterworks. Water will be piped from Cold Springs Canyon and conveyed to a reservoir on the Old Ilo hill.

WHITE SALMON, WASH.—Engineer Geo. A. Kyle has completed a survey for the construction of an electric railway from this place to the S., F. & S. Railway and estimates the cost of construction at $50,000. Local capital will subscribe to part of the stock and the Mt. Adams electric line will subscribe the balance and construct the line.

SAN FRANCISCO, CAL—After a conference between Mayor McCarthy, members of the public utilities committee of the Supervisors and certain directors of the Spring Valley Water Company, it was announced by the Mayor that the water corporation was soon to furnish the city officials with a complete and comprehensive report on the property now owned by the company

SACRAMENTO, CAL.—The scheme to sell to this city water rights near the source of the American River, which are represented as sufficient to give the city a mountain water supply and to develop 29,000 h.p. for a municipal lighting plant, will be laid before the Chamber of Commerce at its next meeting. To purchase these rights and to build the necessary dams and conduits for bringing the water to this city the cost is estimated at $3,000,000.

SEATTLE, WASH.—Bids are being received by C. B. Bagley, secretary of the Board of Public Works, for the improvement of a portion of North Fiftieth street, North Fifty-first street, North Fifty-fourth, Fifty-fifth, Woodlawn circle; West Fifty-fourth, West Fifty-second, First Avenue Northwest, Trinity Place, Terrace Drive, Scenic Place, Second Avenue Northwest, West Fifty-sixth street, Palatine avenue, by the construction of water mains, according to plans on file in the office of the Board of Public Works.

SACRAMENTO, CAL.—D. P. Doake of San Francisco, said to represent certain capitalists who are alleged to have secured certain water rights on the McCloud River, is making an offer through the Chamber of Commerce to sell out to the city for $165,000. The matter is to be discussed at the next meeting of the Chamber. The plan is to supply Sacramento with McCloud River water through a concrete conduit more than 200 miles long. The estimated cost of installing such a plant is $3,000,000. Mr. Doake and his associates ask $165,000 for the engineering work they have done, for their water rights and for securing permanent rights of way. The Natomas Consolidated owns valuable water rights on the American River.

KINGSBURG, CAL.—All the contracts for the construction of Kingsburg's municipal water system have been signed, and actual work is to commence at once. The work was divided up into several sections, but the principal contract has been awarded to Braun, Williams & Russell, of Los Angeles, who are to put in the system with the exception of the wells, hose, power house and the fire apparatus, and the amount of their contract is $19,447.10. A R. Gilstrap of this city is to bore the two 8-inch wells, which are to be 100 feet deep, for $250. Johnson Bros., also of this city, are to build the power house for $1003. The contract to supply 1000 feet of 2½ inch fire hose was given to the Bowers Rubber Works for $900. The water tank is to be of steel, will hold 60,000 gallons, and will rest on a steel tower 100 feet high. The tank itself is 18 feet in diameter, and 31.6 feet high.